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HETEROLOGOUS EXPERIENCE (IMMUNIZATION) AS A FACTOR IN RESISTANCE TO DISEASE

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Instances in which nonfatal experience with one infection or with various nonliving antigens has apparently increased resistance to subsequent exposure to quite different infections or toxic substances have been rather frequently reported. Following is a brief review of the history of the subject:

HISTORICAL REVIEW

As long ago as 1893 Klein found that the intraperitoneal injection of a nonfatal dose of any one of several bacterial cultures would render guinea pigs refractory to an otherwise fatal dose of the same or of unrelated cultures given 8 to 12 hours later by the same route. Sobernheim (1893) confirmed Klein's findings and extended the interval between injections to 3 days. Klein further found that repeated subcutaneous inoculations with cultures of various organisms rendered guinea pigs refractory to usually fatal doses of cholera bacilli given intraperitoneally during an interval of at least 12 days following the last subcutaneous injection. Pfeiffer and Issaef (1894) found that a preliminary intraperitoneal injection of such substances as broth, peptone, urine, and the like so affected the tissues as to render guinea pigs likewise refractory to otherwise fatal doses of *B. cholera* given by the same route.

Vaughan and Palmer (1920) found that certain fractions from split proteins, whatever their source, when inoculated into animals would induce a resistance or tolerance to subsequent injections of similar protein fractions from other sources and also even against infection with bacteria. (The interval between injections extended to 11 and 12 days.) No specific action of the serum could be demonstrated.

Képinov (1924) and Balteau and Tudoranu (1925) also confirmed Klein's observations but used culture filtrates in place of the whole cultures for the primary inoculations.

Calmette and Marchoux (1895) noted that rabbits which had been immunized against abrine were less susceptible to anthrax infection than were controls. They were unable, however, to show that anti-abrine serum had any effect upon anthrax bacilli treated *in vitro*.

Deutschmann (1907) noted that repeated inoculation with yeast rendered animals increasingly resistant against infections.

Following 1918 a number of observers, notably Neumayer (1918), Rickmann (1919), Deusch (1919), Creischer (1919), Amelung (1919), Bochalli (1930) Leichtweiss (1930), and others, noted that influenza tended to attack tuberculous patients less frequently and less severely than was the case among nontuberculous patients. This was most apparent with the earlier and milder types of pulmonary tuberculosis, while those with a severe progressive form tended to bear influenza poorly.

Hirayama (1930) inoculated guinea pigs with virulent tubercle bacilli and in from 5 to 30 days re-inoculated them subcutaneously with anthrax bacilli. The tuberculous animals survived the anthrax inoculation more frequently than did the controls, and death, when it did occur, tended to be later. Similar results were secured in mice. In a later communication Hirayama showed that tuberculous guinea pigs likewise better withstood infection with streptococci and that they also showed a higher resistance to diphtheria toxin than did normal animals.

Ascoli (1928) stated that cultures of tubercle bacilli (B.C.G) administered to calves rendered them nearly refractory to the contagious pneumonia of young calves, which causes great ravages among the unvaccinated animals of Lombardy.

Ninni and de Sanctis Monaldi (1931) found that tubercle bacilli (B.C.G.) injected subcutaneously into guinea pigs rendered the inoculated pigs, after a lapse of 1 to 2 weeks, more resistant to intracutaneous inoculation with anthrax as shown by fewer and later deaths than were the controls.

Wright (1931) also stated that tuberculin (B.E.) increased the resistance of animals against both streptococcus and staphylococcus infections.

The observations of Lewis and Loomis (1924) have a possible bearing upon the action of tuberculosis in subsequent infections. These authors found that guinea pigs inoculated intraperitoneally with bovine tubercle bacilli, when injected three weeks later with sheep corpuscles, responded by a marked increase in hemolysin as compared with control pigs. In some instances the titer was as much as twentyfold greater than in the controls.

Dienes and Schoenheit (1926) showed similarly that tuberculous pigs injected with egg white responded more readily with the production of skin sensitiveness, precipitins, and complement-binding antibodies than did noninfected controls.

Nasta and Weinberg (1931) likewise found that rabbits inoculated with cultures (B.C.G.) one month previously, reacted sensibly higher in their production of hemolysin to sheep cells or in agglutinins against cholera than did normal controls. The same type of response had been noted by Bieling (1919), who showed that animals treated with dysentery bacilli were able to form agglutinins against typhoid bacilli when injected with only a fraction of the amount of antigen that was required to produce agglutinins in normal animals.

Calmette (1932) reported that B.C.G. in infants notably reduces the general mortality, and spoke of it as exerting a sort of "nonspécifique" immunity against diseases having no connection with tuberculosis.

Kinloch (1917) studied the effect of vaccinia upon the course of subsequently acquired acute infections in children under 5 years of age and found both complications and deaths fewer in the previously vaccinated group.

Clark, Zellmer, and Stone (1922) showed that multiple injections with various bacterial vaccines rendered rabbits increasingly resistant to typhoid bacilli intravenously administered some 11 days following the last preparatory inoculation.

Pierce, in 1928, working with syphilis in rabbits, noted that a coincident inoculation with vaccinia and syphilis gave an intensified type of syphilis. However, when the rabbits were inoculated with syphilis subsequent to vaccination the vaccine immune animals showed more resistance to the syphilis than did the controls. That a similar relationship is possible with virus infections is indicated by the work of Busson, who found that guinea pigs recently vaccinated with cowpox virus were often immune to infection with the street virus of rabies. Likewise, Gildemeister and Hilgers (1929) showed that a previous immunization of rabbits against either neurolapine or herpes virus induced an evident degree of protection against a subsequent inoculation with the other virus. Freund (1930) treated guinea pigs intraperitoneally on 5 or 6 successive days with herpes immune rabbit serum. Later when vaccinated on the pad with vaccine virus the "pro-

tected" animals developed smaller and less filled vesicles which dried earlier than was the case with the controls. Freund considered that his work confirmed Gildemeister and Hilger's views of an immunological relationship between the two viruses. This, however, cannot be held as his control pigs did not receive inoculations of normal rabbit serum, and it is possible that the inoculations of the foreign serum were accountable for his results. Bedson and Bland, moreover, attempted to confirm the views of Gildemeister and Hilgers relative to an immunologic relationship between herpes and vaccine virus by carrying out *in vitro* neutralization tests and then inoculating the virus serum mixtures in varying dilutions upon the skin of normal and immunized pigs. They were unable to show the presence of any cross neutralization, but their methods are not comparable to Gildemeister and Hilger's methods and while they do refute the latter's interpretations of their findings, they do not disprove the existence of a cross-protection.

Armstrong (1932) demonstrated that a series of injections with diphtheria toxoid, typhoid vaccine, or even plain broth rendered white mice increasingly resistant to an intracerebral inoculation with vaccine virus. Diphtheria antitoxin, however, administered intraperitoneally one day prior to the intracerebral inoculations offered no increased protection.

In addition, there are certain epidemiological observations bearing upon the influence of heterologous experience; for instance, Van Valzah (1915), at the University of Wisconsin, noted that male students, mainly rural, tended to have suffered fewer ailments prior to entering the university while after entrance they tended to suffer to a greater degree than did women students, recruited mainly from the towns. This difference was apparent in diseases wherein specific immunity due to a previous attack could hardly be considered as a factor. Clark, Zellmer, and Stone (1922) state that Van Valzah's observations have been verified year after year. Love and Davenport (1919) made a similar observation among army camps recruited from rural and city populations. The Poliomyelitis Commission of New York City (1919), moreover, noted that among 954 poliomyelitis patients 1 to 4 years of age the attack rate among the Schick positives was six to seven times as high as among the Schick negative children. Likewise, Ellicott, and Halliday (1930), in their studies of psittacosis in Maryland, noted that in rural homes every person who frequently handled psittacotic parrots or cleaned their cages developed the disease (10 cases), while among 21 similarly exposed city dwellers less than one half (10) developed psittacosis.

The work here reported was undertaken in an effort further to test the effect of heterologous experience upon resistance to disease.

EXPERIMENTAL

Experiment A

This experiment was planned to determine whether immunization of guinea pigs to tetanus would alter their resistance to the action of diphtheria toxin-antitoxin mixture. Since the paralyzing and killing effect of this agent is slow in appearing, it was felt that small differences in resistance could be more certainly shown than if a more rapidly fatal toxin were employed as the test material. The toxin-antitoxin mixture was selected for its strong paralyzing properties, 1 cc regularly paralyzing and killing normal guinea pigs. The tetanus toxoid and toxin used were prepared from an organism belonging to group 3 of Tulloch.

Thirty-two guinea pigs weighing from 200 to 250 grams were divided into 2 groups of 16 each. One group received subcutaneously 5 cc of tetanus toxoid and the control group received subcutaneously at the same time 5 cc of normal salt solution. At the end of 30 days the guinea pigs which received the tetanus toxoid were injected with 5 MLD's of tetanus toxin to test for immunity.

During the 43 days prior to the injection of the toxin-antitoxin mixture, 9 guinea pigs of the 16 being immunized to tetanus and 8 of those receiving salt solution died from intercurrent affections. Two, previously injected with tetanus toxoid and found immune, were added to the 7 immunized animals of this experiment and these 9 animals, together with the 8 controls, were injected, subcutaneously, with 1 cc of diphtheria toxin-antitoxin mixture. During the immediately

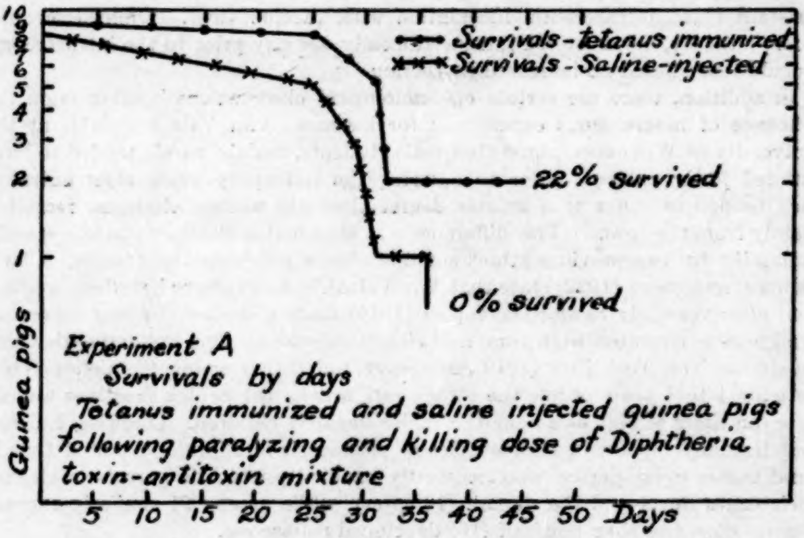

CHART 1

following 45 days, 7 of the 9 tetanus-immune guinea pigs died and 2 survived, 1 with and 1 without paralysis. Of the 8 controls all were dead from paralysis by the thirty-sixth day (chart 1).

Experiment B

This experiment was planned to determine further the increased resistance of tetanus-immune guinea pigs to the paralyzing action of diphtheria toxin and to determine whether this effect might be in part due to the antigenic action of the broth from which the tetanus toxoid was made, and also whether botulinus toxoid would act similarly to tetanus toxoid. Type B botulinus toxoid and toxin were employed.

Sixty-four guinea pigs weighing 250 to 270 grams were divided into 4 groups of 16 each and all were kept under identical conditions. The various groups received 3 injections, at approximately weekly inter-

vals, of 1 cc of tetanus toxoid, botulinus toxoid, broth, and normal salt solution, respectively. Forty days after the last injection the guinea pigs receiving tetanus toxoid were injected with 5 MLD's of tetanus toxin and those receiving botulinus toxoid were injected with 2 MLD's of botulinus toxin, to test for immunity.

Seventy-six days after the first immunizing injection, the surviving guinea pigs in all groups received 1 cc of diphtheria toxin-antitoxin mixture subcutaneously. At this time there were 10 tetanus-immune guinea pigs, 12 immune to botulinus, 12 which had received broth, and 13 which had received salt solution. Forty-five days following the test inoculation 3 tetanus-immune animals were still alive, all had shown paralysis, and 7 had died; 6 botulinus-immune animals had survived, all had shown paralysis, and 6 had died; 2 broth-injected

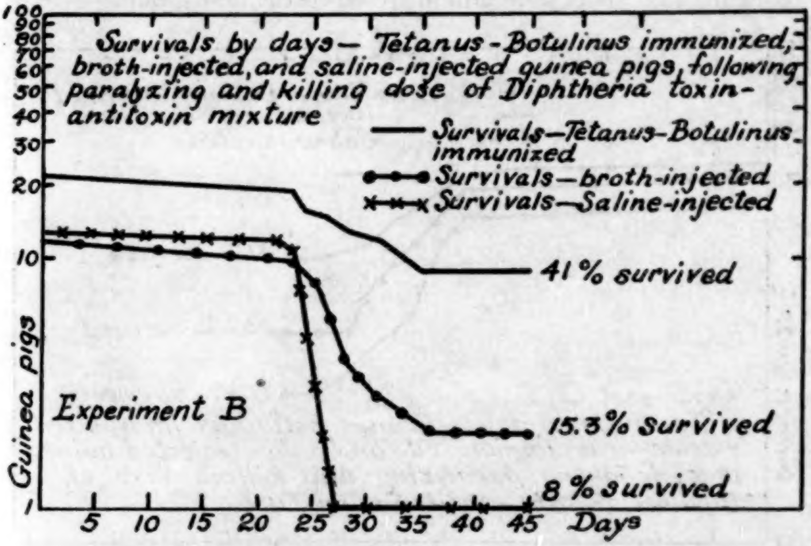

CHART 2

animals had survived, all had shown paralysis, and 10 had died. At the end of the twenty-eighth day, one salt-solution injected guinea pig had survived, all had shown paralysis, and 12 had died. This guinea pig in the salt-solution group surviving with paralysis at the twenty-eighth day did not recover as did the surviving animals in the other groups, but died on the forty-eighth day, 3 days after the termination of the experiment. Chart 2 shows the result of this experiment, the tetanus and botulinus animals being combined in one curve for the sake of simplicity.

Experiment C

This experiment was planned to show the influence upon resistance to diphtheria paralysis induced in guinea pigs by simultaneous immunization to tetanus and botulinus and in guinea pigs immunized to vaccinia.

One hundred and eighty-six animals weighing from 250 to 270 grams were divided into 3 groups. Those in the first group, which contained 98 animals, were injected, subcutaneously, with a mixture of 2 cc of equal parts of tetanus and botulinus toxoid which was repeated after an interval of 18 days. Twenty-eight days after the last injection each surviving animal received 2 MLD's of tetanus and 2 MLD's of botulinus toxin combined as a test for immunity. Those in the second group, 44 animals, were vaccinated on the pad of one hind foot with vaccine virus. This vaccination was done 17 days after the last immunizing injection in the first group in order that the height of the immunity reactions might approximate each other in point of time. The animals of the third group, 44, were injected subcutaneously with 2 cc of normal salt solution on the same dates that the immunizing injections were administered to the first group.

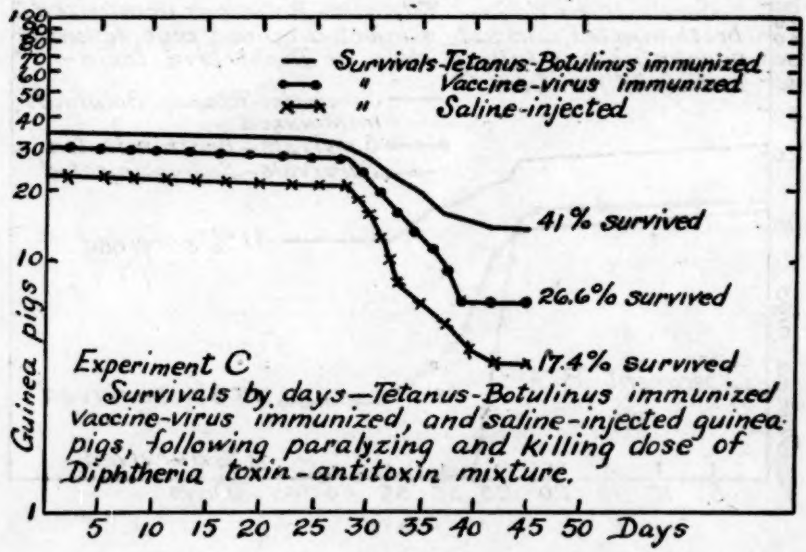

CHART 3

Forty-two days after the last immunizing dose of tetanus-botulinus toxoid and 25 days after the vaccination of the vaccinated group all surviving animals in the three groups were given a paralyzing dose of diphtheria toxin-antitoxin mixture. At the end of 45 days, of 34 tetanus-botulinus immune animals, 14 had survived, 13 with paralysis and 1 without paralysis; 20 had died following paralysis. Of 30 vaccinated animals, 8 had survived with paralysis and 22 had died following paralysis. Of 23 control pigs which had received salt solution, 4 had survived with paralysis and 19 had died following paralysis. The toxin-antitoxin mixture used to inject these groups was from a batch different from that used in experiments A and B, and the dose selected was not strong enough in its paralyzing action to kill all of

the control pigs. The difference in resistance of the different groups is, however, clearly shown (chart 3).

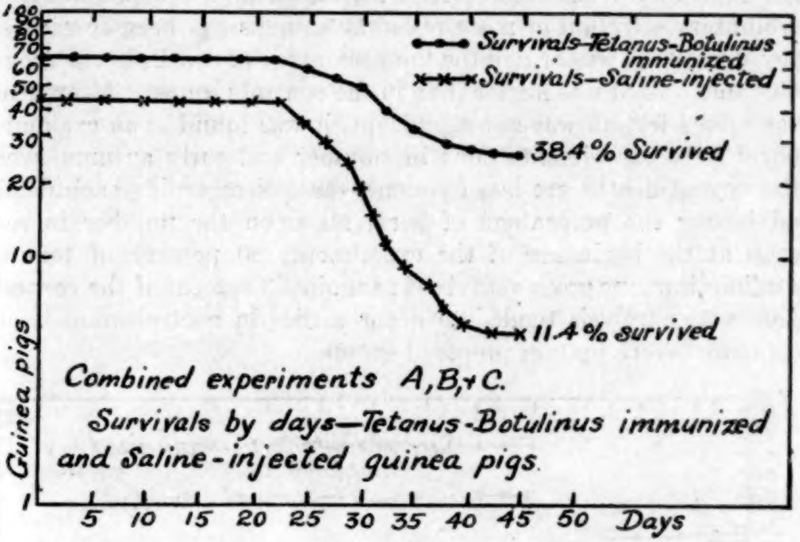

CHART 4

Experiments A, B, and C are combined in chart 4. Curves for animals receiving broth in experiment B and those vaccinated in

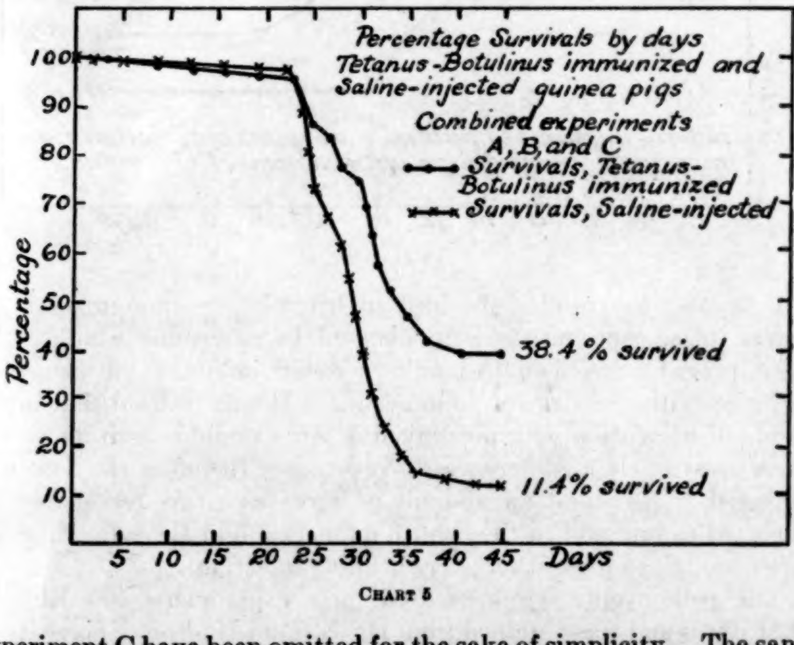

CHART 5

experiment C have been omitted for the sake of simplicity. The same data are shown on a percentage basis in chart 5. All animals in these

experiments were kept under identical conditions as to temperatures, food, and cages. Certain experiments were somewhat handicapped by high mortality from intercurrent infections and the possibility of involuntary selection of more resistant animals has been considered, since during the winter months the percentage of deaths in the groups being immunized was higher than in the control groups. As evidence that such selection was not significant, it was found upon examining figures from experiments done in summer and early autumn, when intercurrent deaths are less frequent, that, disregarding such deaths and basing the percentage of survivals upon the number in each group at the beginning of the experiment, 20 percent of tetanus-botulinus immune groups survived as against 3 percent of the controls. Moreover, paralysis tended to occur earlier in control animals and was more severe than in prepared groups.

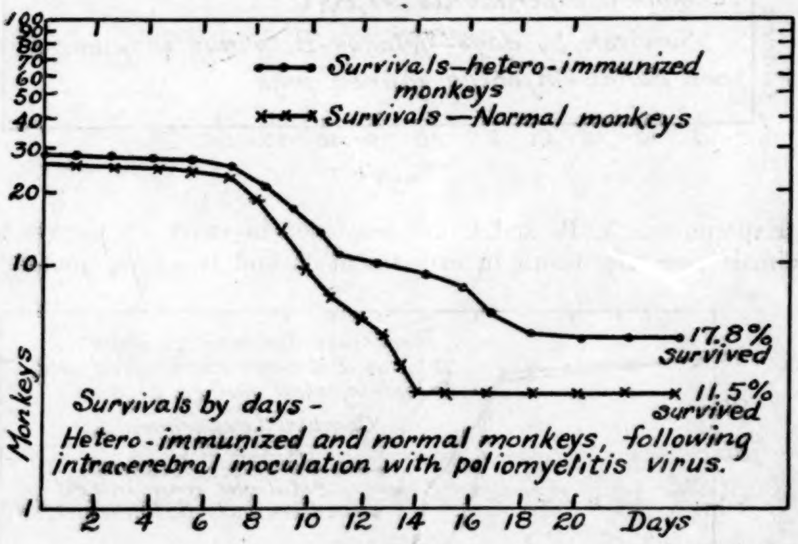

CHART 6

Following the results obtained in heterologous immunization of guinea pigs, experiments were planned to determine whether the same procedure applied to monkeys would influence the course of infection with the virus of poliomyelitis. It was realized that intracerebral inoculation with poliomyelitis virus would constitute a very severe test of slight differences in resistance; therefore the dose was adjusted to as small an amount of virus as could reasonably be expected to bring down the control animals and at the same time not large enough to present an overwhelming infection.

The poliomyelitis virus used in these experiments was Rhoad's P.M. virus and was obtained from Dr. N. Paul Hudson, University of Chicago, in October 1930. This virus is well known for the constancy with which it produces the disease in monkeys. *Macacus rhesus* mon-

keys varying in weight from 3 kg to 4.5 kg were employed. Inoculation was made under intravenous amytal anesthesia, in the right cerebral hemisphere just anterior to the motor area. Virus from the cords of three monkeys was used, sections from different levels being ground in a mortar and suspended in 0.85 percent NaCl solution, the concentration of virus varying from 0.5 to 0.9 percent. The suspension was centrifuged at low speed to remove the sediment, and 0.2 cc of the opalescent supernatant fluid was injected. Test and control animals were alternately inoculated in order that possible deterioration of virus after grinding would not affect the experiment.

Test monkeys were immunized by injection with various antigens, diphtheria toxoid being most constantly used on account of its possible

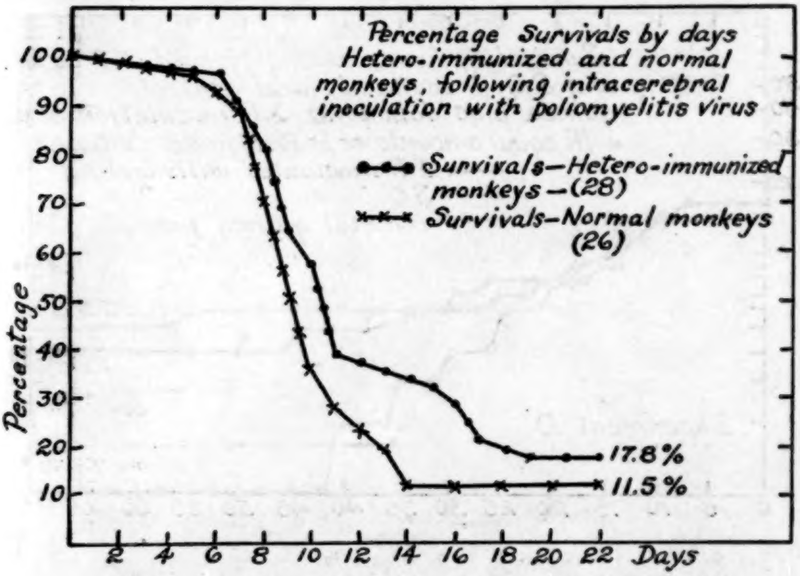

CHART 7

application to public health practice. Tetanus toxoid and vaccine virus were also employed; and in one group, after thorough immunization with diphtheria toxoid, a saline suspension of diphtheria culture was injected. The course of immunization usually extended over a period of 6 to 10 weeks, and the test dose of virus was administered from two to four weeks after the last immunizing dose.

In all, four experiments have been done. In the first experiment, of 7 immunized animals 1 survived after 3 days fever beginning on the eleventh day, and showed slight paralysis of the right shoulder and upper arm. Of six control animals all died.

In the second experiment, of 6 immunized animals all died of the infection, and in 4 controls 1 animal survived with paralysis.

In the third experiment, of 5 immunized animals 2 survived without paralysis, while 1 of 5 controls survived without paralysis.

In the fourth experiment, of 12 immunized animals 2 survived without paralysis, and of 11 controls 1 survived without paralysis.

The results of these four experiments are combined in the curves shown in chart 6. The same data are shown on a percentage basis in chart 7.

Experiment D

In an effort to confirm Klein's findings 48 guinea pigs were divided into 3 groups of 16 pigs each. Group I received 1.5 cc of live typhoid culture suspension intraperitoneally, group II received 1.5 cc of the same suspension subcutaneously, and group III was untreated.

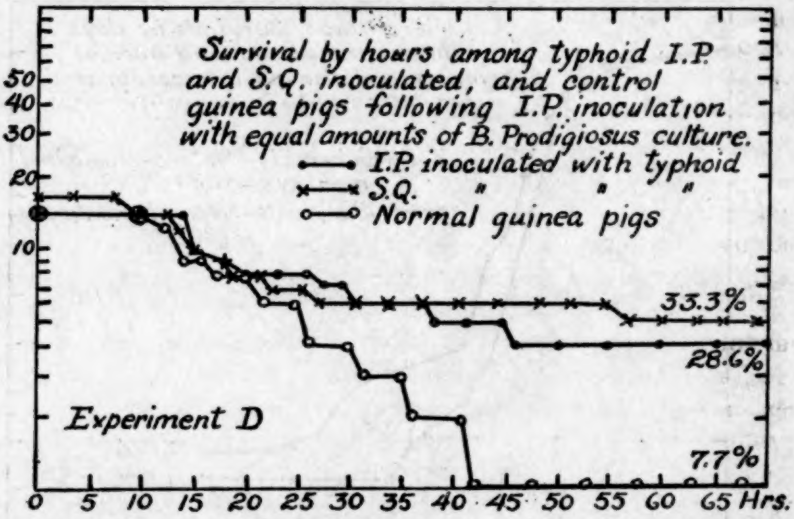

CHART 8

One week following the typhoid inoculations 5 guinea pigs from each of the 3 groups were given 1.3 cc of suspension of live *prodigiosus* bacilli. One from each of the typhoid inoculated groups survived, while all of the controls died.

Two weeks after the typhoid inoculations the remaining animals of each group were given the same dose of *prodigiosus* suspension. As the results were quite similar to those secured after one week, they have been combined. Among 13 animals of group I, 4 survived; among 15 of group II, 5 survived; while among 13 controls only 1 survived. See chart 8.

DISCUSSION

The method by which this increased protection is secured has usually been attributed to a cross-immunity based upon some assumed antigenic relationship between the various substances used in the earlier

and subsequent inoculations. However, the great variety of substances found capable of inducing this increased resistance, together with the failure to find serum antibodies capable of showing passive cross-protection, speak against this view.

In 1919 Love and Davenport commented upon the fact that the incidence of infectious diseases in Army camps recruited from rural areas tended to be higher than was the case in camps recruited from urban populations. These authors fully recognized the part played by specific immunity gained through earlier attacks in reducing the number of later attacks to the usual infectious diseases. They, however, felt that specific protection could hardly account for the lower incidence of such diseases as lobar pneumonia and cerebrospinal meningitis among the troops from urban centers. The authors after discussing several possible explanations state "Another hypothesis is that life in urban communities produces a general resistance to disease of which the observed resistance to measles, mumps, lobar pneumonia, cerebrospinal meningitis, and scarlet fever are only instances."

Clark and his co-workers (1922), commenting upon the observations of Van Valzah relative to the greater incidence of contagion among rural students at the University of Wisconsin as compared to urban students, inquire, "Is there a nonspecific immunity entirely apart from the well-recognized group reactions?" They then suggest, "Through repeated slight injuries to the antibody producing cells should one not expect, on a pathological basis, a hyperplasia of these tissues, an actual extension of the lymphoid tissue or bone marrow for example?" They further suggest that such training of the antibody-producing mechanism should result in a more rapid and greater response in the production of antibodies as a result of a given stimulus.

Armstrong (1932) proposed much the same views, but considered the increased efficiency to be the result of a mobilization, strengthening, and disciplining of the defense tissues due to experience. Thus the defense mechanism is rendered more prompt and effective in its efforts to combat subsequent infections. This conception brings the defense mechanism into line with other better-known tissues wherein functional well-being is so dependent upon judicious exercise.

PRACTICAL APPLICATION

It is admitted that the protection gained through nonspecific experience is only relative and probably of no value in preventing an attack of measles or other highly infectious disease, though it might possibly tend to modify its course. However, the increased resistance might be sufficient to prevent at least some cases of infection with certain diseases possessed of feeble powers of attack, such as post-vaccination encephalitis or poliomyelitis.

SUMMARY

1. Evidence is presented which indicates that exercise of the defense mechanism by inoculation with heterologous antigens increases the resistance of experimental animals to the subsequent action of various infectious agents or toxic substances.

2. It seems probable that this increased resistance occasioned by one antigen or infection is the result of a mobilization, strengthening, and training of the defense mechanism, thus rendering it more prompt and effective in its efforts to combat other subsequent infections.

3. While the increased resistance gained through heterologous experience is only relative, the evidence suggests that it may be sufficient to modify the course of subsequent infections and to be of some value in preventing certain diseases, such as poliomyelitis or post-vaccination encephalitis.

4. In addition to the great protection conferred against diphtheria and smallpox by specific immunization, laboratory evidence indicates that such experiences may be valuable in increasing resistance to various subsequent infections.

BIBLIOGRAPHY

Amelung, W.: Grippe und Lungentuberkulose. Muench. Med. Woch. (1919), **66**: 1321–22.

Armstrong, C.: Post-vaccination encephalitis (with special reference to prevention), Pub. Health Rep. (1932), **47** : 1553–1568.

Ascoli, C.: Cited from Calmette.

Balteau, I., and Tudoranu, G.: Apropos de la note de Képinov sur l'immunité non-spécifique. C.R.Soc. de Biol. (1925), **92** : 119–120.

Bedson, S. P., and Bland, J. O. W.: On the supposed relationship between the viruses of herpes febrilis and vaccinia. Brit. J. Exp. Path. (1928), **9** : 174–178.

Bieling, R.: Untersuchungen über die veränderte Agglutininbildung mit Buhrbacillen vorbehandelter Kaninchen. Ztschr. f. Immunitätsforschung (orig.) (1919), **28** : 246–279.

Bochalli: Grippe und Tuberkulose. Muench. Med. Woch. (1919), **66** : 330.

Busson, B.: Blatternschutz und Tollwutinfektion. Weiner Klin. Woch. (1926), **39** : 1183–1185.

Calmette, A.: Vaccination préventive de la tuberculose de l'homme et des animaux par le B. C. G. Rapports et Documents, Institut Pasteur, Paris, 1932.

Calmette, A. and Marchoux, E.: (1895) Quoted from Calmette.

Clark, P. F., Zellmer, C. E., and Stone, H. W.: Observations in nonspecific immunity. J. of Inf. Dis. (1922), **31** : 215–225.

Creischer, L.: Grippe und Lungentuberkulose. Deutsch. Med. Woch. (1919), **45** : 323.

Department of Health, City of N.Y. The epidemic of poliomyelitis in New York City in 1916 (1917).

Deusch, G.: Grippe und Lungentuberkulose. Muench. Med. Woch. (1919), **66**: 464–465.

Deutschmann, R.: Ein neues tierisches Heilserum gegen microbische Infektionen beim Menschen. Muench. Med. Woch. (1907), **54** : 921–923.

Dienes, L., and Schoenheit, E. W.: Local hypersensitiveness in the guinea pig. Proc. of Soc. f. Biol. Med. (1926), **24** : 32–36.

Ellicott, V. L., and Halliday, C. D.: The psittacosis outbreak in Maryland, December 1929 and January 1930. Pub. Health Rep. (1931), **46** : 843–850. (Reprint 1467).

Freund, H.: Ueber die Immunisatorischen Beziehungen Zwischen Herpes und Vakzine. Zentralbl. f. Bakteriol., etc. (1930), **119** : 25–26.

Gildemeister, E., and Hilgers, P.: Bestehen zwischen Herpes und Vakzine Immunitätsbeziehungen? Zentralb. f. Bakteriol. etc. (1929), **114** : 314–319.

Hirayama, T.: Einfluss der Infektion mit Tuberkelbazillen auf den Verlauf von Milzband. Ztschr. f. Immunitätsforschung (1930), **68** : 218–230.

Hirayama, T.: Ueber die Resistenz tuberkulös infizierte Tiere gegen andere nachträgliche Infectionen. Ztschr. für Immunitätsforschung (1930), **68** : 230–335.

Képinov, Leon: Etude sur l'immunité non-spécifique; action immunisante des filtrates bactériens nonspécifique sur l'infection cholérique. C.R.Soc. de Biol. (1924), **91** : 244–246.

Kinloch, J. P.: The effect of vaccinia on the well-being of children as judged by their reaction to subsequent infection. The Lancet (1917), **192** : 993–995.

Klein, E.: The anticholera vaccination. Brit. Med. J. (Mar. 25, 1893), **1** : 632–634.

Klein, E.: Anticholeraic vaccination. The Lancet (Mar. 25, 1893), **1** : 653–654.

Leichtweiss, F.: Grippe und Lungentuberkulose. Muench. Med. Woch. (1919), **66** : 810.

Lewis, Paul A., and Loomis, Dorothy: Allergic Irritability. Jour. Exp. Med. (1924), **40** : 503–515.

Love, A. G., and Davenport, C. B.: Immunity of city-bred recruits. Arch. of Int. Med. (1919), **24** : 129–153.

Nasta, M., and Weinberg, A.: Sur la production d'anticorps pour différents antigènes chez les lapins vaccinés avec le B. C. G. C.R.Soc. de Biol. (1931), **106** : 992–994.

Neumayer, V. L.: Zur grippe. Muench. Med. Woch. (1918), **65** : 1230.

Ninni, C., and de Sanctis Monaldi, T.: Sur l'immunité paraspécifique déterminée par le B. C. G. à l'égard de l'infection charbonneuse. C.R.Soc. de Biol. (1931), **107** : 1246–1248.

Pfeiffer, R., and Issaeff.: Ueber die specifische Bedeutung der Choleraimmunität. Ztschr. Hyg. u. Infekt. (1894), **17** : 355–400.

Pierce, Louise: The influence of vaccinal immunity on the reaction to infection with experimental syphilis. J. Exp. Med. (1928), **48** : 363–377.

Rickmann: Grippe und Lungentuberkulose. Deut. Med. Woch. (1919), **45**: 39–40.

Sobernheim, G.: Zur intraperitonealen Cholerainfection der Meerschweinchen. Hygienische Bundschau (1893), **111** : 997–1000.

Van Valzah, Robt.: Some deductions from the medical examination of 5,000 students entering the University of Wisconsin. Wisc. Med. Jour. (1915), **14** : 1.

Vaughan, V. C., and Palmer, G. T.: Nonspecific immunity. Military Surgeon (1920), **46** : 1–9.

Wrights, Sir. A. E.: Traitment des infections bactériennes thérapeutiques vaccinales et immunisation *in vitro*. Annales de l'Institut Pasteur (June 1931), **46** : 639–681.

MALARIA IN THE IRRIGATED REGIONS OF NEW MEXICO[1]

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In 1929 the senior writer, with Komp and King (1), reported the results of a survey of malaria made by them in the irrigated regions of the Southwestern United States in 1926, 1927, and 1928. The present paper deals with further work in New Mexico and includes an investigation of the results of certain antimalaria measures begun there three or four years ago. The main object of the more recent undertaking, as of the earlier work, was to estimate the extent of the malaria prob'em in New Mexico and to attempt some definite recommendations as to the best method of dealing with the disease where it had become established and of preventing its further spread.

Malaria is now present in three widely separated regions of the State:

1. *In the valley of the San Juan River, San Juan County, near Farmington.*—Here malaria has but recently appeared. Some six cases were noted in 1931, the history of which indicated that they were the result of local transmission and not relapses of malaria contracted elsewhere. The disease was not known in this locality until the development of certain oil industries brought in a new population, including many persons from regions where malaria is indigenous. The elevation of Farmington is about 5,300 feet above the sea, and the summers are warm. In a survey made there in August 1931 we found numerous *A. maculipennis*, both larvæ and adults, and large areas of swampy meadows suitable for the development of this species. *A. pseudopunctipennis* is also present. In the absence of prompt and vigorous measures, malaria may become as well established and as troublesome there as it is in Rio Arriba County, where climate and species of *Anopheles* are similar.

2. *In the vicinity of Espanola, Rio Grande valley, including portions of Rio Arriba and Santa Fe Counties.*—Here malaria has been indigenous for about 45 years. The elevation is approximately 5,600 feet, and the climate warm from June to September, inclusive. Swampy meadows and ancient beds of the Rio Grande afford abundant breeding places for both *A. maculipennis* and *A. pseudopunctipennis*. In Table 1 are shown the malaria parasite rates of school children, all residing within 15 miles of Espanola. The rates obtained in 1931 are compared with those of previous years. All examinations were made by the same examiner. It will be noted in this table that there has been a decrease in the parasite rate of the region as a whole, a decrease especially marked in San Juan Indian School, where it fell

[1] The studies and observations on which this paper is based were conducted with the support and under the auspices of the International Health Division of the Rockfeller Foundation.

from 28.3 percent in 1926 to 1.3 percent in 1931. On the other hand the rate in San Pedro School has increased and shows for 1931 a very high percentage, 27.3.

TABLE 1.—*Malaria parasite rates of school children in the vicinity of Espanola, New Mexico*

School	1927		1928		1931	
	Number examined	Percent positive	Number examined	Percent positive	Number examined	Percent positive
San Juan Indian [1]	61	13.1	71	11.2	75	1.3
San Juan public [2]					41	2.4
Ranchitos public			17	11.7	11	0.0
Santa Cruz public [2]	65	9.2	77	6.5	78	2.6
Espanola primary [2]	42	0.0			54	3.7
San Pedro public			35	14.3	33	27.3
Alcalde Mission	42	9.5	36	0.0	62	3.2
Velarde Mission	14	21.4	25	4.0	48	6.3
Total	224	9.4	261	8.0	402	5.0

[1] In 1926, 60 examined, 28.3 positive.
[2] Lower grades only examined. In the other schools children of all grades were examined.

3. *Along the Rio Grande in the southern part of the State, throughout Dona Ana County, and in the southern part of Sierra County.*—The elevation at Las Cruces, Dona Ana County, is about 3,800 feet. The summer extends from May to October and is somewhat warmer than in the northern part of the State. *A. maculipennis* and *A. pseudopunctipennis* are present and are mainly produced in drainage ditches and in pools formed by seepage or overflow from irrigation canals.

Malaria in appreciable amount appeared in Dona Ana County in 1926. Its prevalence then and in subsequent years is shown in Table 2, which gives by years the cases reported to the county health officer, Dr. C. W. Gerber (2). These figures indicate a rapid increase between 1926 and 1928 and a subsequent decrease. The decrease, as shown by the case record, is confirmed by our blood parasite surveys of Hill School, Dona Ana County. In 1928 we found 17.9 percent positive among 56 children examined, and in 1931 only 4.4 percent positive among 67 examined.

TABLE 2.—*Cases of malaria reported to the county health office of Dona Ana County, N. Mex. (classification by Dr. C. W. Gerber, county health officer)*

Year	Local new infections [1]	Recurrences	Total	Year	Local new infections [1]	Recurrences	Total
1923	0	2	2	1928	719	216	935
1924	0	3	3	1929	302	176	478
1925	3	4	7	1930	212	166	378
1926	7	20	27	1931 [2]	68	46	114
1927	319	1	320				

[1] Doctor Gerber classifies the infections of the years 1925 to 1929, inclusive, as follows: (a) Malaria contracted previous to coming to Dona Ana County, 43.01 percent; (b) cases contracted in Dona Ana County, 56.84 percent.
[2] Includes all months of 1931 except December.

The three localities in which malaria has appeared have, in common, a high elevation, warm summers, situation in irrigated river valleys, and the presence of *A. maculipennis*. Benign tertian (*P. vivax*) is everywhere the prevalent species of malaria parasite. Estivo-autumnal (*P. falciparum*) appeared in considerable amount in one restricted locality in Dona Ana County during 1927. With that exception, practically no species other than benign tertian has appeared among the hundreds of cases confirmed by blood examination.

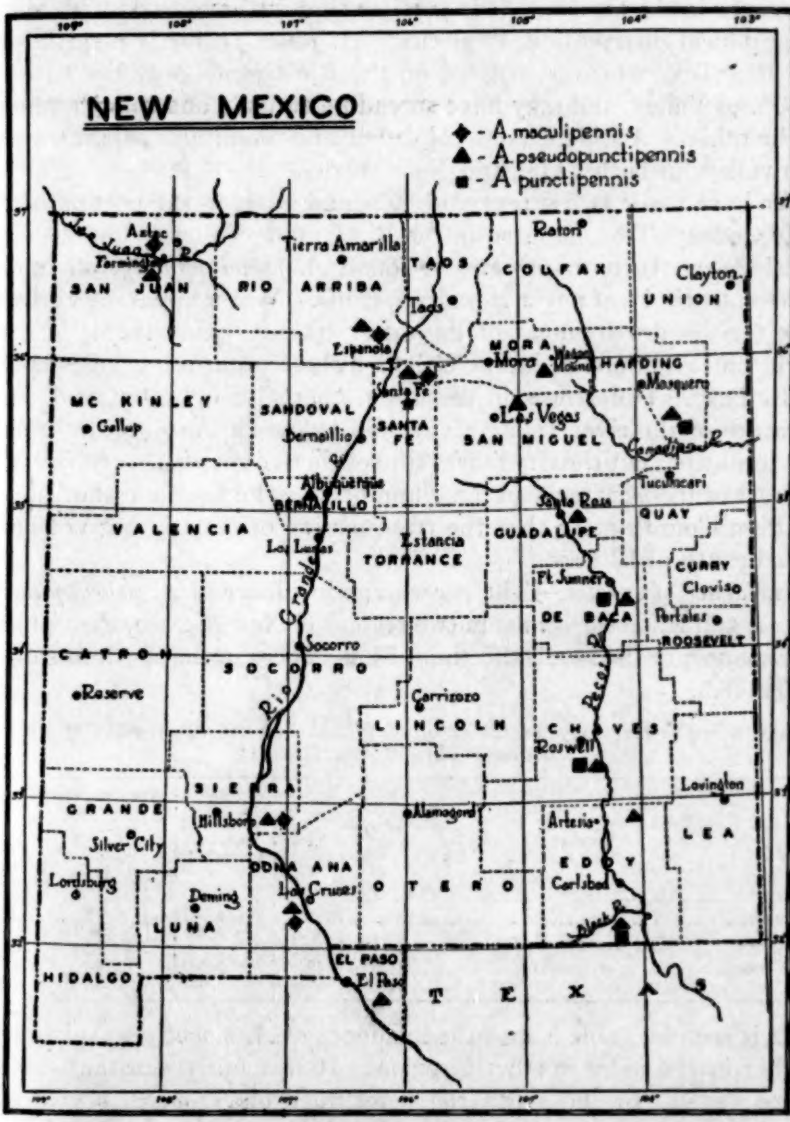
There are localities, at present malaria free, which are quite as favorable for the transmission of the disease as the three previously mentioned, and probably lack only suitable gametocyte carriers to infect mosquitoes. Land along the Rio Grande, especially in the central part of the State, is now being reclaimed from alkali by large drainage ditches; these, when overgrown by aquatic vegetation, are likely to become suitable breeding places for *Anopheles* and perhaps new centers of malaria. Malaria may show a high degree of intensity in New Mexico and, once established, may be very difficult to eradicate. The problem in that State, then, is not a negligible one; and the presence of the disease there is the more to be deplored, since the State is a favored resort of health seekers.

ANOPHELES

The distribution of anopheline species.—The accompanying map shows the distribution of anopheline species in New Mexico. The data are based on our surveys and, since they represent the investigations of only three years, are necessarily incomplete. We examined many hundreds of larvæ as well as adult mosquitoes, but the final determination of species rests chiefly on adult characteristics. We have found only three species in New Mexico, *A. maculipennis*, *A. pseudopunctipennis*, and *A. punctipennis*.

It will be seen on the map that *A. pseudopunctipennis* is widely distributed in the State. It probably occurs wherever suitable water for breeding is present. *A. maculipennis* occurs in the valleys of the San Juan River and the Rio Grande. We have not found this species in the Pecos Valley, although we have made three surveys there (one in 1928 and two in 1931), in the course of which we collected many hundreds of adult anophelines of other species. We have found *A. punctipennis* only in the Pecos Valley. It is very plentiful in the southern part of Eddy County (especially along the Black River), less common northward, but present as far north as the valley of the Canadian River. It breeds in much the same waters as those preferred by *A. maculipennis* in the Rio Grande Valley. It is quite possible that *A. maculipennis* will at some time be found in the Pecos Valley, but if present it must be rare. *A. quadrimaculatus* is present in the lower Rio Grande Valley of Texas and may extend into New

Mexico, but we have been unable to prove that any occurs there. One could easily overlook specimens of *A. quadrimaculatus* in a collection containing *A. maculipennis,* since the adult characteristics of the two species are somewhat similar.



Distribution of Anopheles species in New Mexico

We are unable to explain why *A. maculipennis* should prefer the valley of the Rio Grande and *A. punctipennis* that of the Pecos. The elevation of the Pecos Valley is much less where it passes the southern boundary of New Mexico than is that of the Rio Grande; but both

valleys rise to 6,000 feet or over in the north. The alkalinity of the waters of the Pecos Valley is generally greater than that of the Rio Grande, but both valleys have waters exhibiting great variations in alkalinity, and this factor would hardly suffice to account for a general difference in the species. It is possible that we have to do with mere geographical distribution of species. *A. punctipennis* is plentiful at Del Rio, Tex., which is situated on the Rio Grande near the base of the Pecos Valley, and may have spread upwards in one valley and not in the other. A wide expanse of desert and mountains separates the two valleys in both Texas and New Mexico.

We have made two surveys, in 1928 and 1931, in the portion of El Paso County, Tex., situated in the Rio Grande Valley below the city of El Paso. In both surveys we found *A. pseudopunctipennis* more or less plentiful but never *A. maculipennis*. Water apparently favorable for the development of the latter species occurs there; but we could find no adults or larvæ, although these occur a few miles north of El Paso. Differences in elevation, character of water, and temperature of the river valley above and below El Paso are not great, but it may be that the city marks the southern limit of *A. maculipennis*, at least of its occurrence in large numbers. The health authorities of El Paso County state that the transmission of malaria has not been noted south of El Paso.

Incidence of species.—The percentage incidence of *A. psuedopunctipennis* and *A. maculipennis* in two regions of New Mexico, the vicinity of Espanola in the north and that of Las Cruces in the south, is shown in Table 3.

TABLE 3.—*The percentage incidence of adult Anopheles in two regions of the Rio Grande Valley of New Mexico*

Locality	Year	Number of adults identified	Percentage incidence of—	
			A. maculipennis	A. pseudopunctipennis
Espanola	1927	3,700	77	23
	1928	3,800	80	20
	1931	1,592	82	18
Las Cruces	1928	5,500	33	67
	1931	1,638	11	89

It is seen in Table 3 that the incidence of *A. maculipennis* is much higher in the more northerly region. It was fairly constant during three years. In the south the percentage of *A. maculipennis* was much lower in 1931 than in 1928, probably as the result of antilarval measures undertaken there.

The collections shown in Table 3 were made during the warmer part of the year, for the most part in July, August, and early September. In 1931 we made some collections near Espanola about the middle of October after sharp frosts had begun. In six collections, consisting of three trips to two different outdoor localities, we found only *A.*

maculipennis, although *A. pseudopunctipennis* had been common in both localities during the summer. The total of the October collections was 116 *A. maculipennis*, of which 68.9 percent were females, a slightly higher percentage of females than that furnished by outdoor midsummer collections in the same locality (55.4 percent). Larvae and pupae of *A. maculipennis* were still plentiful in mid-October.

Breeding waters of Anopheles.—In northern New Mexico we can distinguish two extreme types among anopheline breeding waters: (1) those almost completely shaded and containing water cool at all times of the day; (2) those wholly exposed to the sun and filled with aquatic vegetation, thick and extending just to the surface of the water. In the first, *A. maculipennis* is usually the only species found; in the second, *A. pseudopunctipennis* is usually in "pure culture." Between these two extremes of sun exposure the larvae of both species are often found together. Daytime temperature seems to be the determining factor, although cold springs far up in the mountains may contain *A. pseudopunctipennis* if exposed to the sun.

In southern New Mexico also *A. maculipennis* is the species most commonly found in well-shaded waters, and *A. pseudopunctipennis* in the open; but *A. pseudopunctipennis* has a wider range than in the north, and the output of adults is greater than that of *A. maculipennis* (Table 3). *A. punctipennis* in eastern New Mexico breeds in about the same kind of water as does *A. maculipennis* in the Rio Grande valley, but also occurs in river pools more or less exposed to the sun.

A type of breeding place of much sanitary importance in southern New Mexico is formed by the seepage or overflow of water from irrigation canals to borrow pits or lower ground along the canals. These waters become overgrown with grass, reeds, or willows and form excellent breeding places for *A. maculipennis*, the more productive since usually free from larva-eating fish.

Habits of adult Anopheles with reference to human dwellings.—In Dona Ana County we collected inside dwellings 226 adult mosquitoes, of which 52.2 percent were *A. maculipennis* and the remainder *A. pseudopunctipennis;* but of 1,412 collected outdoors only 4.2 percent were *A. maculipennis.* Of the *A. maculipennis* collected within dwellings in the same locality, only 0.8 percent were males, while of those collected outdoors 61.6 percent were males. The percentage of males among adult *A. pseudopunctipennis* was about the same whether collected indoors or not (63 percent and 68 percent, respectively). In a collection of 730 *A. maculipennis* collected indoors in another locality (vicinity of Espanola), 13.7 percent were males; and of 572 collected outdoors, 44.6 were males. Here also the percentage of males among *A. pseudopunctipennis* was about the same whether collected indoors or not. The breeding places of the two species at Espanola were about equidistant from the houses in which the collec-

tions were made. According to our observations generally, the percentage of females among *Anopheles* in daytime resting places is higher where mosquitoes enter buildings in search of blood than where they enter for purposes of shelter only.

Among adults collected indoors a much higher percentage of *A. maculipennis* than of *A. pseudopunctipennis* were found blood-engorged. For example, among 393 *A. maculipennis* collected in houses near Espanola, 88.5 percent were blood-engorged; while among 39 *A. pseudopunctipennis* also found indoors, only 38.5 percent contained blood. Collections of the two species made in Dona Ana County showed much the same conditions of blood-engorgement.

On the whole, it appeared that *A. maculipennis* enter human dwellings in search of blood, while *A. pseudopunctipennis* seek dwellings as they would any other shelter.

Some curious examples of variation in the house-seeking habits of *A. pseudopunctipennis* occurred. We made almost daily visits to two houses about one-quarter of a mile apart and almost equidistant from the breeding places of *A. pseudopunctipennis* and *A. maculipennis*. The proportion of *A. pseudopunctipennis* in one house was only 2.3 percent, while in the other it was over 30.0 percent. The latter house was nearer the stables than the former. In another locality one of a group of houses (Muñoz) contained only *A. maculipennis* while the house was occupied. When the family moved out, leaving the house vacant, *A. pseudopunctipennis* became the dominant species. In a house immediately adjoining and continuously occupied *A. maculipennis* continued to be almost the only species found. It may be that *A. pseudopunctipennis* is repelled by some domestic odor, possibly smoke, to a greater degree than is *A. maculipennis*.

Susceptibility to malaria parasites; sporozoite and oocyst rates.—In 1931 we made dissections of *A. maculipennis* and of *A. pseudopunctipennis* collected in two regions, the vicinity of Espanola, northern New Mexico, and Dona Ana County, in the south. The results appear in Table 4.

TABLE 4.—*Oocyst and sporozoite rates of A. maculipennis and A. pseudopunctipennis collected in New Mexico, 1931*

Species and place of collection	Oocysts in the stomach			Sporozoites in the salivary glands		
	Number examined	Number positive	Percent positive	Number examined	Number positive	Percent positive
A. maculipennis:						
Within dwellings	201	6	2.9	705	6	0.9
Outside of dwellings	53	0	0.0	156	0	0.0
Total	254	6	2.4	861	6	0.7
A. pseudopunctipennis:						
Within dwellings	77	0	0.0	99	0	0.0
Outside of dwellings	80	0	0.0	158	0	0.0
Total	157	0	0.0	257	0	0.0

The total percentage positive, whether of stomachs or salivary glands, were as follows: *A. maculipennis*, 868 examined, 1.4 percent positive; *A. pseudopunctipennis*, 263 examined, none positive. Specimens positive for sporozoites occured in both northern and southern regions. In both localities, however, the actual percentage positive of *A. maculipennis* would be below that shown in Table 4, for we not only collected the majority of the specimens described in that table from human dwellings, but made repeated collections in houses most likely to furnish positives. However, our results show that malaria-infected *A. maculipennis* occurs in nature in two widely separated localities and in numbers sufficient to be of sanitary significance. The best comparison of the infection rates of *A. maculipennis* and *A. pseudopunctipennis* is afforded by collections of the two species made in the same houses and at a time when one or the other species showed some positives, that is, when an effective gametocyte carrier was present or had recently been present in the neighborhood. Satisfying these conditions we have in our series, *A. maculipennis* 331, with 3.3 percent positive, and *A. pseudopunctipennis* 51, with no positives.

We describe in more detail one incident which may illustrate the general course of events concerned in the transmission of malaria in northern New Mexico, that of a house (Bustos) in which a number of persons slept in an unscreened room. We made nine daily collections (September 22 to September 30) in this room. The number of female *A. maculipennis* collected varied from 14 to 73 daily, with no tendency to diminution as the catches continued. Specimens positive for malaria parasites were found on the first day and appeared occasionally up to the eighth day, at first showing only oocysts, later only sporozoites. We examined blood specimens of the family occupying the house and found one boy 10 years old with numerous benign tertian parasites but no gametocytes. He had no recent history of illness. No other member of the family was then positive. At the time when we were finding positive *A. maculipennis* in the Bustos house we also made collections in another unscreened house about a quarter of a mile away. Among 232 *A. maculipennis* taken in the second house and dissected, not one positive specimen was found.

About five days after the collections from the Bustos house had been discontinued we examined blood specimens of children in the local school. Among the positives was a child of the Bustos family who had not been positive at the time when the blood specimens of the family were examined.

It appears from this series of observations that *Anopheles* were being infected by a carrier in ordinary health and that, later, malaria was transmitted to another member of the family. Large numbers of *A. maculipennis* must have entered the unscreened room and bitten this carrier. Of the positive specimens collected in the Bustos house

(eight in all), nearly all had sporozoites in the salivary glands or nearly mature oocysts in the stomach, so they must have been infected almost two weeks previously. It seems probable, then, that the infected *Anopheles* spent part of the time outdoors, else they would all have been caught during the first few days. But few, if any, of them strayed as far as the second house, one-quarter of a mile away.

About a quarter of a mile from the Bustos house, a pasture continually flooded with irrigation water furnished a highly productive breeding place of *Anopheles*. The owner of the Bustos house said he was going to put in a screen door "next year."

On the whole, the evidence we obtained in 1931 tends to confirm the conclusion of previous years, that *A. maculipennis* is the chief carrier of malaria in New Mexico. The epidemiological evidence is not decisive: we have in the State malaria-free localities which contain *A. maculipennis*, as well as those which contain only *A. pseudopunctipennis;* but in a general way *A. maculipennis* and endemic malaria coincide. The house-visiting habits of *A. maculipennis* and, above all, its infection with sporozoites prove that it is a carrier in New Mexico. *A. pseudopunctipennis* is a known vector of malaria in South America and *A. punctipennis* a proved carrier in the laboratory, so that neither species can be exonerated; but it is probable that in New Mexico neither is as dangerous as *A. maculipennis*, if they are vectors at all. Hermes and his colleagues in California regard *A. maculipennis* as the chief carrier of malaria in that State.

ANTIMALARIA MEASURES

Drainage.—As an antilarval measure, drainage has limited value in an irrigated region. Indeed, the drainage ditches constructed to prevent water-logging of the soil are the chief producers of *Anopheles* in southern New Mexico. In some localities wet pastures formed by turning irrigation or spring water over fields constitute a most prolific source of *Anopheles*. Here ditching may be of much value in preventing mosquito breeding without materially interfering with agriculture, since it may allow of intermittent instead of continuous irrigation of the land. A good example of wet pasture breeding is found in the San Pedro neighborhood (Table 1), where a single ditch would greatly diminish the production of *A. maculipennis* in a community severely plagued by malaria. Some ditches were made by Mr. W. H. W. Komp, of the United States Public Health Service, in 1928 near the San Juan Indian pueblo. These were not properly maintained by the local authorities, and their value has not been permanent. The Indians have clogged the ditches by roads, and the beavers by building dams across them.

Larvicides.—The use of Paris green in New Mexico was discussed in a previous paper (1). It is certainly effective in drainage ditches,

where the use of oil is hardly practicable. But it is difficult to cope with rural malaria by larvicides alone in a region where breeding places are so abundant. One county may have nearly 250 miles of drainage ditches, as well as innumerable pools; and it is no small matter to treat and inspect all of these adequately. It is probable that larvicides are best limited to local or temporary control of anopheline breeding. Dr. C. W. Gerber, health officer of Dona Ana County, has employed larvicides for several years. There has been a marked reduction of *Anopheles* in the county, especially of *A. maculipennis*. *Gambusia* have also been introduced, but it is only fair to ascribe a considerable portion of the reduction in *Anopheles* to larvicides.

Gambusia.—This minnow is apparently not indigenous to New Mexico. It was introduced into El Paso County, Tex., by R. E. Tarbett, of the United States Public Health Service, in 1921 or 1922. From there it spread up the Rio Grande as far as Vado, N.Mex. In 1927 we imported it from Mississippi into Rio Arriba County, northern New Mexico, and into Dona Ana County in the south. Doctor Gerber has distributed it in Dona Ana County, and we have spread it widely along the upper Rio Grande Valley near Espanola and into San Juan County. It thrives well in New Mexico, becoming very numerous in favorable waters, but never to the extent of constituting a nuisance. Once introduced it will spread widely without artificial aid through waters lying at about the same level, but it seems to have difficulty in ascending an abrupt rise of a few feet. Further, there are important breeding places, such as those formed by seepage from irrigation ditches, which become dry during a part of the year. In others, fish may be killed out by freezing. It is necessary, therefore, to make occasional inspections and to redistribute the minnows where needful.

As to the efficiency of this minnow in New Mexico there seems to be little doubt. We made careful surveys of a series of breeding places along the Rio Grande in 1927 and again in 1931 after *Gambusia* had become well established. Some breeding persisted, of course, especially in thick mats of horizontal aquatic vegetation; but the total amount of breeding, especially that of *A. maculipennis*, had materially diminished. A prolific breeding place of *A. maculipennis* is afforded by grass or reeds hanging into water at the sides of drainage ditches. These grassy margins seem quite accessible to *Gambusia*, and in *Gambusia*-stocked ditches they contain but few larvae, while in unstocked ditches they may contain many larvae. We made some careful comparisons of this type of breeding place in southern New Mexico before and after *Gambusia* had become established; and in 1931 we compared the drainage ditches of Dona Ana County, where

Gambusia is plentiful, with those of the Pecos Valley, where the minnows had not yet been introduced.

The malaria parasite rate of certain localities in northern New Mexico has fallen since the establishment of *Gambusia* in them, notably in the neighborhoods represented by San Juan and Ranchitos schools (Table 1), where *Gambusia* has been longest present and most thoroughly distributed. With regard to the decrease in malaria at San Juan, the evidence of the parasite rates is supported by the testimony of the physician in charge of the pueblo and by that of the resident nurse, and also by that very convenient malariometer, the sale of chill tonics, which has materially decreased. Adult *A. maculipennis* have become few in the houses of the neighborhood. In the San Pedro neighborhood, where the malaria rate is high and increasing, the chief breeding place is above the level of the river, and *Gambusia* has not yet become established there. Adult *A. maculipennis* is very plentiful in the neighborhood.

In Dona Ana County, southern New Mexico, a marked reduction in the prevalence of *Anopheles*, especially of *A. maculipennis* (Table 2), has occurred during the past three years. Larvicides have undoubtedly contributed much to this reduction; but some credit should be given to *Gambusia*. In pools formed by seepage from irrigation canals and inaccessible to *Gambusia*, breeding has diminished less than in the drainage ditches, which have become well populated with minnows. Further, in the portion of El Paso County, Tex., which lies below El Paso, *A. pseudopunctipennis* has diminished and *A. maculipennis* is rare or lacking. There *Gambusia* is well distributed, but no larvicides have been used in the drainage ditches. The reduction of malaria in Dona Ana County is shown in Table 2. The diminution of *Anopheles*, however, is not the only factor which has contributed to this reduction in malaria. The county health officer, Doctor Gerber, has treated carriers with quinine and plasmochin and has encouraged people to repair defective screens and to call in a doctor when ill.

Screening.—The screening of dwellings is much more general in the Rio Grande Valley than in the eastern part of Southern United States. Approximately 90 percent of the houses in Dona Ana County are screened, but good screening is less general in the northern part of the State. We made a survey of the condition of screens in the San Pedro neighborhood near Espanola, a locality where malaria is now very prevalent (parasite rate of school children over 27 percent) and has apparently been increasing. Sixty-one houses, nearly every one in a small isolated neighborhood, were surveyed. Four were wholly unscreened. Of the 57 with more or less screening, about 10 had screened doors and the windows screened to the top, with all screens in good condition. Twelve had only the doors screened. Six had

screened verandas. With regard to the condition of the screening, we classified 17 as good, 22 as fair, and 14 as poor.

In our examination of blood specimens of school children of this neighborhood, we found eight families infected. None of these lived in the unscreened houses; three were in houses which could be classified as well-screened, and the other five in houses poorly screened. An unscreened or very poorly screened house may be of much danger to a neighborhood, and it may be that some of the cases which occurred in the well-screened houses owed their infection to mosquitoes coming from houses of the Bustos type (see description above).

It appears from our observations in New Mexico that the mere installation of screens in a region is not sufficient, even though a very large percentage of the houses are screened. The screens must be kept in order and the people taught to use them properly. Poor or partial screening may have some value, but it is not sufficient to prevent an increase and high prevalence of malaria.

Educational work.—Education in health matters is especially needed in some parts of New Mexico. Many of the people seem to have little knowledge regarding the means by which ordinary diseases are transmitted and are often slow to call in a physician when seriously ill. A health officer in a northern county told us that many of the Spanish Americans there would not call in a doctor until they had sufficient money in pocket to pay the bill. As a result, severe cases of contagious diseases might not be reported until after people in contact with the patient had been endangered for days. It would seem that a very little education would suffice to cure that type of neglect. But people, even those well-to-do, are prone to neglect malaria, and education may help to convince them of their duty to the public in this matter. Education should be centered on the following: The method by which malaria is transmitted; the avoidance of improper spread of irrigation water; the careful use of screens; and the necessity of adequate treatment when ill.

Domestic animals.—The domestic animals pasture in the open during most of the summer and are not very snugly housed during the winter. We saw but one really tight barn in northern New Mexico. Conditions throughout the State are not particularly favorable for the deviation of *Anopheles* to domestic animals.

Other possible antimalaria factors.—Among minor factors of known or reputed value in the prevention of mosquito breeding several may be mentioned:

Alfalfa and sweet clover are common in New Mexico but apparently offer no hindrance to the spread of malaria.

Chara is very abundant; but larvæ of both *A. maculipennis* and *A. pseudopunctipennis* grow well in its presence. Anopheline larvae are often found in water nearly filled with this plant.

Duckweed grows thickly enough in certain pools to offer some hindrance to the growth of larvæ, but is apparently unable to flourish in the majority of breeding waters.

Bats are abundant along the Black River in southeastern New Mexico. We saw large numbers of them pursuing insects at night in a locality about 15 miles from the Carlsbad Caverns, which are said to harbor three million bats. But adult *A. punctipennis* and *A. pseudopunctipennis* are present by the hundreds in daytime resting places along the Black River, and the waters of this stream swarm with anopheline larvae.

Summary of antimalaria measures.—The measures especially suitable for the prevention and cure of malaria in New Mexico may be summarized as follows:

1. Distribution of *Gambusia.*
2. Prevention of improper use of irrigation water.
3. Treatment of malaria cases, preferably through the cooperation of physicians.
4. Education regarding the way malaria is transmitted, and the necessity for adequate treatment of the disease and the proper use of screens.
5. Larvicides for local or temporary use.

In localities in which no malaria has appeared, the only antilarval measure which may be indicated is the distribution of *Gambusia.* These minnows may now be obtained in New Mexico from counties in which they are established. Information in regard to places where they may be obtained may be had from the Director of Public Health at Santa Fe. It is easy to transport the minnows in five-gallon gasoline cans. They should first be placed in permanent waters with shallow margins, preferably those fed by springs, since these are less likely to dry up or to freeze during the winter. When they have become numerous they may be scooped up in a sieve or fine net and distributed to all waters in the locality. If the identity of a species of minnow is in doubt, information may be obtained by sending samples in formalin to the Bureau of Fisheries, Washington, D.C.

In localities where malaria has become established, more thorough methods may be necessary. *Gambusia* should be introduced if not already present, and redistributed every spring or as often as is necessary to keep all waters well stocked. Special attention should be paid to borrow pits or other temporary water collections formed by seepage or overflow from irrigation canals. Treatment of carriers should be looked after. Education should be promoted in schools and elsewhere to teach people the way malaria is transmitted, the necessity for adequate treatment, and the maintenance and proper use of screens. Larvicides may be necessary to do away with a mosquito nuisance or for local or temporary protection against malaria, but it is

doubtful whether they can be profitably used year after year on a country-wide basis. The free and general distribution of quinine, except possibly in an emergency, is likewise a measure of doubtful practicability. Any permanent procedure which may interfere with the cooperation of the physicans is of questionable value.

We believe that the spread of *Gambusia* has been of material assistance in the reduction of malaria in New Mexico and should not be omitted from any antimalaria plan. The treatment of the sick and educational work also rank high among antimalaria measures and are within the means of most health authorities. None of the measures recommended here requires a large additional outlay of funds in the case of counties already provided with a health officer and visiting nurses.

SUMMARY

1. Malaria is now present in New Mexico in at least three widely separated regions. Once established, it may persist in a region for many years.

2. Of the three species of *Anopheles* common in New Mexico, *A. maculipennis*, *A. pseudopunctipennis*, and *A. punctipennis*, the first is certainly a carrier of malaria there and may be the only one of importance. It is common in the valleys of the Rio Grande and the San Juan River, but is rare or lacking in the Pecos Valley. *A. punctipennis* is commonest in southeastern New Mexico; *A. pseudopunctipennis* is present everywhere in the State.

3. Of the preventive and curative measures applicable in New Mexico, the spread of *Gambusia*, treatment of carriers, and education regarding the necessity of treatment and proper use of screens seem the most promising.

REFERENCES

(1) Barber, M. A., Komp, W. H. W., and King, C. H.: Malaria and the malaria danger in certain irrigated regions of the Southwestern United States. Pub. Health Rep., vol. 44, no. 22, pp. 1300-1315, May 31, 1929.

(2) Gerber, C. W.: Summary of malaria control work in Dona Ana County, N.Mex. Southwestern Medicine, vol. 15, no. 8, p. 370, August, 1931.

COURT DECISION RELATING TO PUBLIC HEALTH

Provision of borough ordinance as to burial permit held abrogated by State vital statistics law.—(Pennsylvania Superior Court; Borough of Yeadon *v.* Galen, 164 A. 837; decided Mar. 3, 1933.) An ordinance of the borough of Yeadon, enacted in 1895, provided that no dead body should be brought into the borough for burial without giving certain specified information to the secretary of the borough board of health and also obtaining a burial permit, the fee for which was $1.

The State vital statistics statute of 1915 provided that the body of a person dying in the State should not be interred until a permit for burial, removal, or other disposition had been issued by the local registrar of the registration district in which the death occurred. With reference to the removal of a body from one district to another in the State, such act provided:

But a burial permit shall not be required from the local registrar of the district in which interment is to be made when a body is removed from one district in Pennsylvania to another district in the State for purpose of burial or other disposition, either by common carrier, hearse, or other conveyance, and no local registrar shall, as such, require from undertakers, or persons acting as undertakers, any fee for the privilege of burying dead bodies.

The defendant, an undertaker, secured a burial or removal permit from the registrar for Philadelphia county in connection with the death of a person in the city of Philadelphia. He arranged for the interment of the body in a cemetery in the borough of Yeadon. He exhibited the permit he had obtained to the secretary of the borough board of health but did not secure a permit or pay the $1 fee as provided by the above mentioned borough ordinance. The body was interred in the borough and thereafter an action was brought for the violation of the ordinance. The defendant was convicted and he appealed to the superior court. That court took the view that the conviction of the defendant could not be sustained, saying, in part, as follows:

* * * the act of 1915 provides, as we have shown, that a second permit and the payment of an additional fee shall not be required.

* * * The title and the substance of the act of 1915 evinces an intention on the part of the legislature to provide not only vital statistics but also a general system throughout the commonwealth for issuing burial permits in conjunction with other legislation for the protection of the public health, and, incidentally, that unnecessary permits and expense be avoided.

The act of May 4, 1927, P.L. 519, section 2801 (53 PS, section 15021) is derived from and now supplies the act of 1851 to which we have referred and provides as follows: "Boroughs may prohibit within their limits or within any described territory within such limits the burial or interment of deceased persons and may regulate the depth of graves." The construction which we have placed upon the act of 1915 allows the section of the borough code to which we have referred and the provisions of the act of 1915 to stand but abrogates and nullifies that provision of the ordinance in question which would have required of the defendant a permit from the secretary of the board of health of the borough and the payment of a fee. The conviction of the defendant cannot be sustained.

PUBLIC HEALTH SERVICE PUBLICATIONS

A List of Publications Issued During the Period July–December 1932

There is printed herewith a list of publications of the United States Public Health Service issued during the period July–December 1932.

The most important articles that appear each week in the PUBLIC HEALTH REPORTS are reprinted in pamphlet form, making possible a wider and more economical distribution of information that is of especial value and interest to public-health workers and the general public.

All of the publications listed below except those marked with an asterisk (*) are available for free distribution and as long as the supply lasts may be obtained by addressing the Surgeon General, United States Public Health Service, Washington, D.C. Those publications marked with an asterisk are not available for free distribution but may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C., *at the prices noted.* (No remittances should be sent to the Public Health Service.)

Periodicals

Public Health Reports (weekly), July–December, vol. 47, nos. 27–53, pages 1419 to 2394.

Venereal Disease Information (monthly), July–December, vol. XIII, nos. 7–12, pages 253 to 412. (Annual index in December issue.)

Reprints from the Public Health Reports

*1539. Epidemic of mild dysentery-l ke disease in Cattaraugus County, N.Y., summer of 1930. By Dorothy G. Wiehl and Mary Gover. July 1, 1932. 8 pages. 5 cents.

1540. Observations on the agglutination of Proteus X organisms in Rocky Mountain spotted fever. By Gordon E. Davis and R. R. Parker. July 15, 1932. 12 pages.

1541. Postvaccination encephalitis with special reference to prevention. By Charles Armstrong. July 22, 1932. 16 pages.

1542. Report of Committee on Milk. Conference of State and Provincial health authorities, June 2, 1932. August 12, 1932. 4 pages.

1543. The metamorphoses of streptococci into spore-bearing rods and into filterable forms. By Alice C. Evans. August 19, 1932. 16 pages.

1544. Relation of oxidation to proteolysis in malignant tumors. By Carl Voegtlin and Mary E. Maver. March 25, 1932. 16 pages.

1545. The incidence and time distribution of common colds in several groups kept under continuous observation. By W. H. Frost and Mary Gover. September 2, 1932. 27 pages.

1546. Studies on immunity induced by mouse sarcoma 180. By H. B. Andervont. September 9, 1932. 19 pages.

*1547. Biological products. Establishments licensed for the propagation and sale of viruses, serums, toxins, and analogous products. September 9, 1932. 6 pages. 5 cents.

1548. Etiology of trachoma with reference to relationship of Bacterium granulosis (Noguchi) to the disease. By Ida A. Bengtson. September 16, 1932. 22 pages.

*1549. Do children who drink raw milk thrive better than children who drink heated milk? By Leslie C. Frank, F. A. Clark, W. H. Haskell, M. M. Miller, F. J. Moss, and R. C. Thomas. September 23, 1932. 10 pages. 5 cents.

*1550. Public health education. The functions of the university and of the private foundation. By John Sundwall. October 7, 1932. 16 pages. 5 cents.

*1551. An epidemic of motor neuritis in Cincinnati, Ohio, due to drinking adulterated Jamaica ginger. History, symptomatology, and clinical report. By Charles E. Kiely, Murray L. Rich, A. R. Vonderahe, T. J. LeBlanc, and W. E. Brown. October 14, 1932. 25 pages. 5 cents.

1552. Public Health Service publications. A list of publications issued during the period January–June, 1932. October 21, 1932. 2 pages.

*1553. Excess mortality from causes other than influenza and pneumonia during influenza epidemics. By Selwyn D. Collins. November 11, 1932. 21 pages. 5 cents.

*1554. Plasmochin in malaria prevention. Experiments in Alabama. By J. N. Baker and D. G. Gill. December 2, 1932. 6 pages. 5 cents.

*1555. Recent court decisions on milk control. By James A. Tobey. December 2, 1932. 8 pages. 5 cents.

*1556. Standardization of morbidity reporting and development of the morbidity reporting area. By R. C. Williams. December 9, 1932. 16 pages. 5 cents.

*1557. Rocky Mountain spotted fever (eastern type). Virus recovered from the dog tick Dermacentor variabilis found in nature. By L. F. Badger. December 30, 1932. 5 pages. 5 cents.

*1558. Endemic typhus fever virus recovered from wild rat trapped at typhus focus in the United States. By R. E. Dyer, W. G. Workman, and A. Rumreich. December 30, 1932. 5 pages. 5 cents.

Supplements to the Public Health Reports

*103. Chemistry of the opium alkaloids. By Lyndon F. Small assisted by Robert E. Lutz. 1932. 375 pages. $1.00.

*104. The notifiable diseases. Prevalence during 1930 in States. 1932. 10 pages. 5 cents.

*105. The notifiable diseases. Prevalence during 1931 in States. 1932. 14 pages. 5 cents.

Public Health Bulletins

*202. Frequency of pneumonia among iron and steel workers. By Dean K. Brundage, Albert E. Russell, Roy R. Jones, J. J. Bloomfield, and Lewis R. Thompson. November 1932. 51 pages. 5 cents.

*203. A study of the pollution and natural purification of the upper Mississippi River. Surveys and laboratory studies. By H. R. Crohurst. December 1932. 113 pages. 10 cents.

National Institute of Health Bulletin

*160. Further studies on the pharmacology of certain phenol esters with special reference to the relation of chemical constitution and physiologic action. By Maurice I. Smith, E. W. Engel, and E. F. Stohlman. The histopathology of some neurotoxic phenol esters. By R. D. Lillie and Maurice I. Smith. August 1932. 69 pages. 10 cents.

Unnumbered Publication

*Index to Public Health Reports, vol. 47, part 1 (January–June 1932). 23 pages. Out of print.

Reprints from Venereal Disease Information

40. The British treatment center. By R. A. Vonderlehr. From Venereal Disease Information, vol. XII, no. 12. 4 pages.
41. Cooperative clinical studies in the treatment of syphilis. Early syphilis. By Taliaferro Clark, Thomas Parran, Harold N. Cole, Joseph Earle Moore, Paul A. O'Leary, John H. Stokes, and Udo J. Wile. Vol. XIII, nos. 4, 5, 6, and 7. 87 pages.

DEATHS DURING WEEK ENDED MAY 13, 1933

[From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce]

	Week ended May 13, 1933	Corresponding week, 1932
Data from 85 large cities of the United States:		
Total deaths	7,694	8,023
Deaths per 1,000 population, annual basis	10.8	11.4
Deaths under 1 year of age	570	683
Deaths under 1 year of age per 1,000 estimated live births [1]	48	56
Deaths per 1,000 population, annual basis, first 19 weeks of year	11.9	12.4
Data from industrial insurance companies:		
Policies in force	68,204,929	73,278,071
Number of death claims	13,435	14,368
Death claims per 1,000 policies in force, annual rate	10.3	10.3
Death claims per 1,000 policies, first 19 weeks of year, annual rate	10.8	10.5

[1] 1933, 81 cities; 1932, 80 cities.

PREVALENCE OF DISEASE

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

CURRENT WEEKLY STATE REPORTS

These reports are preliminary, and the figures are subject to change when later returns are received by the State health officers

Reports for Weeks Ended May 20, 1933, and May 21, 1932

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended May 20, 1933, and May 21, 1932

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932
New England States:								
Maine		3	2	5	1	296	0	0
New Hampshire		3			37	98	0	0
Vermont	1				34	262	0	0
Massachusetts	32	37		2	473	1,156	0	1
Rhode Island	2	4			1	84	0	0
Connecticut	5	3	3	3	281	299	1	1
Middle Atlantic States:								
New York	60	93	[1] 11	[1] 12	2,428	3,216	6	5
New Jersey	19	31	2	19	1,073	1,092	0	1
Pennsylvania	51	76			1,296	1,905	2	15
East North Central States:								
Ohio	13	23	11	11	529	1,526	0	1
Indiana	21	19	25	12	291	143	2	4
Illinois	20	81	25	87	953	1,174	14	5
Michigan	16	11	5	13	915	2,908	3	5
Wisconsin	1	9	25	22	355	2,397	3	1
West North Central States:								
Minnesota	3	9	1	4	778	63	1	2
Iowa	6	7			76	6	0	2
Missouri	16	32			234	100	2	2
North Dakota		3			64	49	1	0
South Dakota	1	2			19	7	0	0
Nebraska	2	15			275	5	0	0
Kansas	9	11	1	1	282	414	2	3
South Atlantic States:								
Delaware		1			8		0	0
Maryland [2]	2	12	6	9	30	59	0	2
District of Columbia	1	5			19	18	0	0
Virginia	5				365		1	
West Virginia	6	12	1	39	100	215	0	1
North Carolina	11	16	1	74	739	672	0	3
South Carolina [3]	8	6	162	625	415	203	0	0
Georgia [3]	2	6		89	178	55	0	0
Florida [3]	4	11		5	19	13	0	1

See footnotes at end of table.

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended May 20, 1933, and May 21, 1932—Continued

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932
East South Central States:								
Kentucky	3	13	6	37	35	73	0	1
Tennessee	4	8	21	37	86	10	2	1
Alabama [3]	8	6	4	26	74	7	0	0
Mississippi	6	8	---	---	---	---	0	0
West South Central States:								
Arkansas	1	6	---	19	227	1	0	1
Louisiana	5	21	5	17	42	52	0	1
Oklahoma [4]	1	4	10	29	223	48	3	1
Texas [3]	49	18	92	20	1,088	89	1	0
Mountain States:								
Montana [5]	2	1	3	1	56	117	0	0
Idaho [5]	---	3	2	---	16	---	0	0
Wyoming [5]	---	---	---	1	15	29	0	0
Colorado [5]	2	7	27	---	3	104	0	1
New Mexico	3	9	2	28	8	36	0	0
Arizona	---	5	3	1	135	---	0	2
Utah [2]	1	2	---	---	17	---	0	0
Pacific States:								
Washington	10	5	---	---	84	223	1	0
Oregon [5]	3	8	46	30	55	256	0	0
California [5]	37	75	28	59	1,221	696	2	2
Total	452	741	530	1,337	15,653	20,176	47	65

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932
New England States:								
Maine	0	0	11	25	0	0	3	2
New Hampshire	0	0	22	38	0	0	0	0
Vermont	0	0	10	12	0	7	0	0
Massachusetts	0	0	363	523	0	0	5	4
Rhode Island	0	0	28	63	0	0	0	0
Connecticut	0	0	112	106	0	0	3	0
Middle Atlantic States:								
New York	1	2	653	1,517	1	3	6	16
New Jersey	0	3	208	280	0	0	1	2
Pennsylvania	0	1	728	1,024	0	0	8	5
East North Central States:								
Ohio	2	1	421	225	2	19	8	1
Indiana	1	0	71	52	0	6	5	1
Illinois	1	1	435	281	5	3	12	8
Michigan	0	1	456	464	0	4	2	7
Wisconsin	0	0	111	63	6	0	2	1
West North Central States:								
Minnesota	0	0	101	90	0	5	3	1
Iowa	0	0	25	39	16	45	1	4
Missouri	0	0	56	33	0	0	5	6
North Dakota	0	0	5	5	0	6	1	0
South Dakota	0	0	5	5	0	0	0	0
Nebraska	0	0	25	25	0	12	0	0
Kansas	1	1	31	25	1	12	5	4
South Atlantic States:								
Delaware	1	0	15	11	0	0	0	1
Maryland [3]	0	0	95	80	0	0	2	4
District of Columbia	0	0	8	20	0	0	0	1
Virginia	1	1	35	---	0	---	5	---
West Vriginia	0	0	7	14	0	0	4	13
North Carolina	2	0	39	40	1	0	9	13
South Carolina [3]	0	1	0	3	2	0	14	18
Georgia [3]	0	0	9	6	0	0	11	10
Florida [3]	0	0	2	1	0	0	1	3

See footnotes at end of table.

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended May 20, 1933, and May 21, 1932—Continued

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932	Week ended May 20, 1933	Week ended May 21, 1932
East South Central States:								
Kentucky	0	0	6	91	0	12	2	4
Tennessee	1	0	60	10	0	14	4	10
Alabama [3]	1	0	10	5	0	13	2	3
Mississippi	0	0	4	6	1	21	6	6
West South Central States:								
Arkansas	0	0	2	2	3	7	0	4
Louisiana	1	0	8	14	1	16	6	23
Oklahoma [4]	0	1	10	11	2	14	1	0
Texas [3]	0	0	57	20	28	23	25	5
Mountain States:								
Montana [5]	0	0	3	14	1	4	1	1
Idaho [5]	0	0	1	6	12	0	1	0
Wyoming [5]	1	0	3	6	1	0	0	0
Colorado [5]	0	0	32	25	4	2	0	2
New Mexico	0	0	5	12	0	0	3	3
Arizona	0	0	8	11	1	0	1	0
Utah [2]	0	0	6	1	0	0	0	2
Pacific States:								
Washington	0	0	50	14	8	22	2	2
Oregon [5]	0	0	20	8	11	10	1	4
California [5]	4	2	146	203	25	17	8	11
Total	18	15	4,518	5,529	132	297	179	207

[1] New York City only.
[2] Week ended Friday.
[3] Typhus fever, week ended May 20, 1933, 26 cases: 1 case in South Carolina, 5 cases in Georgia, 1 case in Florida, 11 cases in Alabama, and 8 cases in Texas.
[4] Figures for 1933 are exclusive of Oklahoma City and Tulsa and for 1932 are exclusive of Tulsa only.
[5] Rocky Mountain Spotted fever, week ended May 20, 1933, 35 cases: 9 cases in Montana, 9 cases in Idaho 12 cases in Wyoming, 1 case in Colorado, 3 cases in Oregon, and 1 case in California.

SUMMARY OF MONTHLY REPORTS FROM STATES

The following summary of cases reported monthly by States is published weekly and covers only those States from which reports are received during the current week.

State	Meningococcus meningitis	Diphtheria	Influenza	Malaria	Measles	Pellagra	Poliomyelitis	Scarlet fever	Smallpox	Typhoid fever
April 1933										
Alabama	5	49	202	39	393	62	2	43	8	26
Arizona	2	2	15		420	1	0	36	0	3
Arkansas	2	32	65	45	1,496	86	0	11	67	5
Idaho			3		155		0	23	39	10
Illinois	86	103	169	3	2,700		4	1,992	32	29
Indiana	16	80	146		817		3	944	13	8
Maryland	5	27	43		76	1	0	417	0	12
Minnesota	1	28	3		4,480		1	382	4	3
Missouri	12	133	76	5	1,232		0	489	28	6
New Mexico	1	32	24	4	56		0	46	5	9
Ohio	7	139	274	0	3,024		6	3,848	23	33
Oregon		13	160	1	364		1	100	21	6
Pennsylvania	20	286			6,038		3	3,912	0	22
Puerto Rico		53	124	1,984	221	8	0		0	30
Rhode Island	0	15			5		0	113	0	1
South Dakota	2	9	5		54	1	0	82	2	11
West Virginia	3	48	42		725		1	94	5	17

April 1933

	Cases
Botulism:	
Maryland	1
Chicken pox:	
Alabama	73
Arizona	62
Arkansas	175
Idaho	75
Illinois	2,175
Indiana	304
Maryland	615
Minnesota	270
Missouri	235
New Mexico	59
Ohio	2,034
Oregon	118
Pennsylvania	3,787
Puerto Rico	113
Rhode Island	86
South Dakota	168
West Virginia	259
Conjunctivitis:	
New Mexico	4
Diarrhea and enteritis:	
Ohio	10
Dysentery:	
Maryland	1
Oregon	1
Pennsylvania	1
Puerto Rico	290
Filariasis:	
Puerto Rico	7
Food poisoning:	
Ohio	6
German measles:	
Arizona	9
Arkansas	18
Illinois	205
Maryland	16
New Mexico	4
Ohio	183
Pennsylvania	52
Hookworm disease:	
New Mexico	1
Impetigo contagiosa:	
Illinois	1
Maryland	7
Oregon	40
Lead poisoning:	
Illinois	1
Maryland	1
Ohio	8
Lethargic encephalitis:	
Alabama	8
Illinois	8
New Mexico	1
Ohio	4
Pennsylvania	3
Mumps:	
Alabama	167
Arizona	138
Arkansas	65
Mumps—Continued	
Idaho	30
Illinois	685
Indiana	171
Maryland	741
Missouri	404
New Mexico	112
Ohio	285
Oregon	12
Pennsylvania	1,854
Puerto Rico	26
Rhode Island	46
South Dakota	26
West Virginia	5
Ophthalmia neonatorum:	
Arkansas	3
Illinois	6
Maryland	2
Missouri	2
Ohio	73
Pennsylvania	4
Puerto Rico	5
Paratyphoid fever:	
Arkansas	1
Idaho	1
Illinois	1
Puerperal septicemia:	
Illinois	5
New Mexico	1
Ohio	3
Pennsylvania	10
Puerto Rico	16
Rabies in animals:	
Illinois	34
Indiana	24
Maryland	2
Missouri	18
Rocky Mountain spotted fever:	
Idaho	8
Oregon	12
Pennsylvania	1
Scabies:	
Maryland	7
Oregon	26
Septic sore throat:	
Illinois	23
Maryland	15
Missouri	20
Ohio	371
Oregon	3
Rhode Island	2
South Dakota	2
Tetanus:	
Alabama	6
Illinois	3
Maryland	1
Ohio	3
Pennsylvania	1
Puerto Rico	11
Rhode Island	1
Tetanus, infantile:	
Puerto Rico	24
Trachoma:	
Alabama	2
Arizona	95
Arkansas	2
Illinois	30
Minnesota	1
Missouri	58
Ohio	8
Oregon	1
Pennsylvania	1
Puerto Rico	8
Trichinosis:	
Illinois	7
Maryland	1
Ohio	8
Oregon	1
Tularaemia:	
Arkansas	3
Maryland	2
Missouri	1
Oregon	1
Typhus fever:	
Alabama	15
Illinois	1
Undulant fever:	
Arizona	3
Idaho	1
Illinois	4
Maryland	3
Minnesota	3
Missouri	5
Ohio	8
Oregon	2
Pennsylvania	2
Vincent's angina:	
Illinois	57
Maryland	8
Oregon	9
Whooping cough:	
Alabama	192
Arizona	138
Arkansas	89
Idaho	20
Illinois	285
Indiana	122
Maryland	138
Minnesota	717
Missouri	86
New Mexico	57
Ohio	441
Oregon	42
Pennsylvania	867
Puerto Rico	185
Rhode Island	103
South Dakota	19
West Virginia	58
Yaws:	
Puerto Rico	1

WEEKLY REPORTS FROM CITIES

City reports for week ended May 13, 1933

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Maine:											
Portland	0	------	0	0	1	1	0	1	2	8	18
New Hampshire:											
Concord	0	------	0	0	3	0	0	0	0	0	10
Manchester	0	------	0	0	1	0	0	0	0	0	7
Nashua	0	------	0	0	0	0	0	0	0	3	------
Vermont:											
Barre	0	------	0	0	0	0	0	1	0	0	1
Burlington	0	------	0	1	0	4	0	0	0	0	13
Massachusetts:											
Boston	6	------	0	272	19	96	0	15	3	45	211
Fall River	2	------	0	0	0	4	0	2	0	10	33
Springfield	0	------	0	1	0	0	0	0	0	9	27
Worcester	0	------	0	33	6	16	0	2	0	8	------
Rhode Island:											
Pawtucket	0	------	0	0	0	5	0	0	0	0	12
Providence	2	------	0	1	1	16	0	2	0	18	42
Connecticut:											
Bridgeport	0	1	3	27	0	15	0	2	2	3	24
Hartford	0	------	0	8	2	15	0	2	0	0	39
New Haven	0	------	0	8	6	9	0	0	0	7	34
New York:											
Buffalo	5	------	0	60	11	40	0	10	0	49	146
New York	61	12	7	1,929	136	244	0	98	8	129	1,487
Rochester	0	1	0	4	3	24	0	5	0	10	72
Syracuse	0	------	0	0	2	18	0	0	1	1	38
New Jersey:											
Camden	2	------	0	32	2	7	0	1	0	0	35
Newark	0	1	0	273	6	27	0	11	0	32	81
Trenton	0	------	0	26	1	8	0	1	1	1	35
Pennsylvania:											
Philadelphia	4	7	5	445	26	116	0	22	5	2	451
Pittsburgh	1	2	0	7	13	65	0	9	0	31	144
Reading	0	------	0	24	1	6	0	2	0	13	23
Scranton	1	------	------	1	------	7	0	------	0	0	------
Ohio:											
Cincinnati	4	------	1	15	11	39	0	10	0	1	113
Cleveland	9	55	3	5	12	163	0	13	1	33	164
Columbus	0	------	0	16	2	17	0	5	0	0	66
Toledo	0	1	0	251	4	146	0	3	1	3	50
Indiana:											
Fort Wayne	1	------	0	1	1	13	0	0	1	0	------
Indianapolis	0	------	0	131	9	13	0	5	0	7	------
South Bend	1	------	0	1	0	3	0	0	0	11	20
Terre Haute	0	------	1	32	0	7	0	0	0	0	18
Illinois:											
Chicago	2	3	4	505	53	290	1	48	1	25	705
Cicero	0	------	0	2	0	3	0	0	0	0	7
Peoria	------	------	------	------	------	------	------	------	------	------	------
Springfield	0	------	0	0	0	3	0	0	0	0	19
Michigan:											
Detroit	14	------	1	505	17	155	0	28	1	111	248
Flint	0	3	0	24	1	7	0	1	0	5	20
Grand Rapids	1	------	0	5	1	9	0	0	0	17	36
Wisconsin:											
Kenosha	0	------	0	1	0	2	1	0	1	12	12
Madison	1	------	------	61	------	4	0	------	0	2	------
Milwaukee	0	1	1	3	9	35	0	5	0	62	101
Racine	0	------	0	0	0	6	0	1	0	12	6
Superior	0	------	0	2	0	0	0	0	0	16	6
Minnesota:											
Duluth	0	------	0	14	1	2	0	1	0	37	20
Minneapolis	3	------	0	34	8	42	0	1	0	28	106
St. Paul	0	------	0	312	4	24	0	4	0	76	58
Iowa:											
Des Moines	6	------	------	0	------	9	6	------	0	0	27
Sioux City	1	------	------	3	------	3	0	------	0	3	------
Waterloo	0	------	------	1	------	2	2	------	0	0	------
Missouri:											
Kansas City	2	1	1	39	10	35	0	8	0	1	119
St. Joseph	0	------	0	36	1	1	0	0	0	1	9
St. Louis	12	2	------	83	5	11	0	9	0	4	173

City reports for week ended May 13, 1933—Continued

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
North Dakota:											
Fargo	0	------	1	2	0	3	0	0	0	0	5
Grand Forks	0	------	0	0	0	1	0	0	0	0	------
Nebraska:											
Omaha	1	------	0	128	5	4	1	3	0	10	60
Kansas:											
Topeka	0	------	0	108	0	0	0	0	0	4	15
Wichita	0	------	0	1	1	2	0	0	1	3	18
Delaware:											
Wilmington	0	------	0	12	4	1	0	1	0	0	34
Maryland:											
Baltimore	2	2	1	4	15	57	0	12	0	10	168
Cumberland	0	------	0	4	0	1	0	0	0	0	12
Frederick	0	------	0	0	0	0	0	0	0	0	1
District of Col.:											
Washington	5	------	0	30	12	17	0	12	0	6	155
Virginia:											
Lynchburg	0	------	0	31	0	2	0	0	0	8	13
Norfolk	0	------	0	18	0	3	0	2	0	7	25
Richmond	0	------	0	5	3	5	0	1	1	0	41
Roanoke	2	------	0	19	0	6	0	0	0	3	17
West Virginia:											
Charleston	3	------	0	0	1	0	0	0	0	0	10
Huntington	0	------	------	1	------	1	0	------	0	0	------
Wheeling	0	------	0	39	0	0	0	1	0	5	10
North Carolina:											
Raleigh	------	------	------	------	------	------	------	------	------	------	------
Wilmington	0	------	0	69	1	0	0	0	0	0	9
Winston-Salem	0	------	0	22	0	5	0	1	0	1	11
South Carolina:											
Charleston	0	1	1	0	2	0	0	1	1	13	23
Columbia	0	------	0	0	0	0	0	0	0	0	------
Greenville	0	------	0	7	0	0	0	0	0	1	7
Georgia:											
Atlanta	1	16	0	19	4	4	0	5	2	23	73
Brunswick	0	------	0	0	0	0	0	0	0	0	3
Savannah	0	10	0	0	1	1	0	0	0	0	29
Florida:											
Miami	0	------	0	0	2	0	0	2	0	14	16
Tampa	0	------	0	0	2	0	0	0	0	4	17
Kentucky:											
Ashland	1	------	0	4	0	1	0	0	0	3	------
Lexington	0	------	0	2	2	1	0	1	0	0	12
Louisville	2	------	0	4	3	13	0	3	0	3	54
Tennessee:											
Memphis	0	------	0	50	6	3	0	5	0	33	60
Nashville	0	------	0	6	3	4	0	1	0	0	34
Alabama:											
Birmingham	1	------	0	4	2	4	0	2	2	4	50
Mobile	0	------	0	16	0	1	0	1	0	0	19
Montgomery	1	------	0	52	------	0	0	------	0	4	------
Arkansas:											
Fort Smith	1	------	0	1	------	0	0	------	0	0	------
Little Rock	0	------	0	216	5	1	0	2	1	0	9
Louisiana:											
New Orleans	4	3	2	10	10	2	0	11	1	0	151
Shreveport	1	------	1	0	0	0	0	5	0	0	38
Texas:											
Dallas	13	------	0	------	2	5	1	4	0	4	58
Galveston	0	------	0	0	1	0	0	0	0	0	13
Houston	3	------	0	3	10	3	2	7	0	0	86
San Antonio	2	------	2	20	7	1	0	6	0	0	73
Montana:											
Billings	0	------	0	0	0	1	0	0	0	0	4
Great Falls	0	------	0	0	1	1	0	0	0	3	10
Helena	0	------	0	0	0	0	0	0	0	0	5
Missoula	0	------	0	1	1	0	0	0	0	0	6
Idaho:											
Boise	0	------	0	7	0	1	1	1	0	0	9
Colorado:											
Denver	3	23	1	7	11	13	0	2	0	3	74
Pueblo	0	------	0	0	1	0	0	0	0	3	7
New Mexico:											
Albuquerque	2	------	0	0	0	0	0	2	1	8	8

City reports for week ended May 13, 1933—Continued

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Utah:											
Salt Lake City	0		0	15	3	4	0	2	0	26	30
Nevada:											
Reno	0		0	0	0	0	0	1	0	0	2
Washington:											
Seattle	2			2		17	0		2	16	
Spokane	0			0		0	1		0	1	
Tacoma	0		0	0	1	0	1	1	1	0	21
Oregon:											
Portland	0		0	3	8	16	0	2	0	1	75
Salem	0	2		8		0	0		0	0	
California:											
Los Angeles	16	15	1	468	15	44	8	24	0	52	263
Sacramento	0		0	3	0	2	0	1	1	59	
San Francisco	1	4	0	5	4	7	0	11	0	73	150

State and city	Meningococcus meningitis		Poliomyelitis cases
	Cases	Deaths	
Massachusetts:			
Boston	1	0	0
Rhode Island:			
Providence	2	0	0
New York:			
New York	3	2	0
Pennsylvania:			
Philadelphia	2	0	0
Pittsburgh	1	0	0
Indiana:			
Indianapolis	1	0	1
Illinois:			
Chicago	15	6	0
Michigan:			
Detroit	1	0	0
Flint	0	0	1
Wisconsin:			
Milwaukee	1	1	0
Minnesota:			
Minneapolis	1	0	0
St. Paul	1	0	0

State and city	Meningococcus meningitis		Poliomyelitis cases
	Cases	Deaths	
Iowa:			
Sioux City	1	1	0
Missouri:			
Kansas City	0	1	0
St. Joseph	2	0	0
Nebraska:			
Omaha	1	0	0
Maryland:			
Cumberland	0	1	0
District of Columbia:			
Washington	1	0	0
Tennessee:			
Memphis	1	0	0
Arkansas:			
Little Rock	1	1	0
Washington:			
Seattle	1	0	2

Lethargic encephalitis.—Cases: Philadelphia, 1; Cleveland, 1; Detroit, 1.

Pellagra.—Cases: Washington, 1; Charleston, S.C., 2; Birmingham, 1; Mobile, 1; Montgomery, 1; New Orleans, 1.

Typhus fever.—Cases: Savannah, 1; Tampa, 1; Montgomery, 1.

FOREIGN AND INSULAR

CANADA

Provinces—Communicable diseases—Two weeks ended May 6, 1933.—The Department of Pensions and National Health of Canada reports cases of certain communicable diseases for the two weeks ended May 6, 1933, as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Cerebrospinal meningitis					1		1			2
Chicken pox		11	2	273	505	67	30	10	218	1,116
Diphtheria		1	5	27	19	13	1	2	3	71
Erysipelas				16	9	3		1	1	30
Influenza		11		5	21	1			2	40
Lethargic encephalitis						1				1
Measles	18	14	28	388	315	11	6	2	24	806
Mumps		1			475	46	15		99	636
Paratyphoid fever					4				1	5
Pneumonia	1	2			19				11	33
Poliomyelitis				2						2
Scarlet fever	1	10	7	144	122	29	19	7	10	349
Smallpox					1					1
Trachoma									2	2
Tuberculosis	1	6	20		95	18	1	7	55	203
Typhoid fever		6	3	32	4	4		1	6	56
Undulant fever					10					10
Whooping cough				107	175	85	11	14	8	400

PALESTINE

Vital statistics—Years 1931 and 1932.—During the years 1931 and 1932, births and deaths were reported in Palestine as follows:

	1931	1932
Number of births	46, 011	43, 538
Birth rate per 1,000 population	48. 07	44. 14
Number of deaths	21, 149	21, 958
Death rate per 1,000 population	22. 09	22. 26
Deaths under 1 year per 1,000 births	170. 09	153. 17

Certain diseases were reported in Palestine during the years 1931 and 1932, as follows:

Disease	1931		1932		Disease	1931		1932	
	Cases	Deaths	Cases	Deaths		Cases	Deaths	Cases	Deaths
Cerebrospinal meningitis	4	3	5	5	Pneumonia	709	414	722	433
Diphtheria	125	12	180	19	Poliomyelitis	3	2	16	
Dysentery	297	12	405	25	Puerperal fever	40	21	35	18
Influenza	108	6	790	22	Relapsing fever	16		13	
Lethargic encephalitis			1	1	Scarlet fever	372	4	243	2
Measles	7, 783	731	4, 507	337	Typhoid fever	905	76	1, 212	119
Paratyphoid fever	204	4	220	7	Typhus fever	51		30	1
					Undulant fever	16		5	

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

(NOTE.—A table giving current information of the world prevalence of quarantinable diseases appeared in the PUBLIC HEALTH REPORTS for May 26, 1933, pp. 586-596. A similar cumulative table will appear in the PUBLIC HEALTH REPORTS to be issued June 30, 1933, and thereafter, at least for the time being, in the issue published on the last Friday of each month.)

Cholera

India—Bombay—Colong.—On April 25, 1933, a case of cholera was reported at Colong, on the railroad between Karachi and Rohri, British India. This case was reported in the Public Health Reports issued May 26, 1933, as having occurred in Karachi.

Philippine Islands.—During the week ended May 20, 1933, 9 cases of cholera with 8 deaths were reported in the Province of Leyte, Philippine Islands.

Plague

Bolivia.—During the month of March 1933 several cases of plague were reported in Tomina Province, Department of Chuquisaca, Bolivia.

Peru.—During the month of April 1933 a confirmed case of plague was reported at Monsefu, and a suspected case at Villa Eten, Chiclayo Province, Department of Lambayeque, Peru.

Smallpox

Bolivia.—During the month of March 1933, 21 cases of smallpox were reported in La Paz; isolated cases in several communities in the same department; 3 cases in Potosi; and some isolated cases in Oruro.

Mexico.—During the month of March 1933, 66 cases of smallpox, with 7 deaths, were reported in cities in Mexico. Eleven cases with 1 death were reported in Mexico, D.F.; 4 cases in Aguascalientes; 4 cases in Chihuahua; 3 cases in San Luis Potosi; and 5 cases in Tijuana.

Typhus fever

Bolivia.—During the month of March 1933, 50 cases of typhus fever were reported in La Paz; isolated cases in several communities in the same Department; and 21 cases in Potosi.

Chile.—During the week ended March 18, 1933, 30 cases of typhus fever were reported in Chile. One case was reported in Santiago; 2 cases in Concepcion; 1 case in Serena; and 3 cases in Talcahuano.

Mexico.—During the month of March 1933, 53 cases of typhus fever, with 10 deaths, were reported in cities in Mexico. Fourteen cases, with 2 deaths, were reported in Mexico, D.F.; 4 deaths in Aguascalientes; 7 cases, with 1 death in San Luis Potosi; and 21 cases, with 1 death, in Zacatecas.

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